New headquarters of the Mines Branch of the Department of Mines, corner of Sussex and George Streets, Ottawa.

SUMMARY REPORT

OF THE

MINES BRANCH

OF THE

DEPARTMENT OF MINES

FOR THE CALENDAR YEAR ENDING DECEMBER 31

1911

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
PRINTED BY C. H. PARMELEE, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY
1912

To His Royal Highness the Duke of Connaught and Strathearn, K.G., etc., Governor General of Canada.

MAY IT PLEASE YOUR ROYAL HIGHNESS:

The undersigned has the honour to lay before Your Royal Highness, in compliance with 6–7 Edward VII, Chapter 29, Section 18, the Summary Report of the work of the Mines Branch of the Department of Mines during the calendar year ending December 31, 1911.

(Signed) ROBERT ROGERS,
Minister of Mines.

HON. ROBERT ROGERS,
Minister of Mines,
Ottawa.

SIR,—I have the honour to submit herewith, the Director's Summary Report of the work of the Mines Branch of the Department of Mines during the calendar year ending December 31, 1911.

I am, sir, your obedient servant,

(Signed) A. P. LOW,
Deputy Minister.

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SUMMARY REPORT

OF THE

MINES BRANCH OF THE DEPARTMENT OF MINES

FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1911.

A. P. Low, Esq., LL.D.,
Deputy Minister,
Department of Mines.

Sir,—I have the honour to submit, herewith, the Summary Report of the Mines Branch of the Department of Mines for the calendar year ending December 31, 1911.

ADDITIONS TO STAFF.

The following additions to the Mines Branch staff were made during the year:—

H. E. Baine, appointed June 6, 1911, as chief draughtsman.

A. H. A. Robinson, B.Ap.Sc., appointed May 11, 1911, as assistant mining engineer.

John Blizard, B.Sc., appointed August 1, 1911, as technical engineer.

Frederick Ransom, B.Sc., appointed May 11, 1911, as assistant mining engineer.

Walter M. Vincent, appointed April 1, 1911, as filing clerk.

Gordon H. Simpson, appointed August 9, 1911, as distribution clerk.

Miss B. W. Russell, appointed April 1, 1911, as typewriter of technical reports.

ORGANIZATION: CLASSIFIED LIST OF STAFF.

The following is a complete list of technical officers and other employes at present on the staff of the Mines Branch:—

INSIDE SERVICE.

Administration staff:—

Miss J. Orme, secretary.
W. Vincent, filing clerk.
G. Simpson, mailing and distribution clerk.
Miss B. Russell, technical typewriter.
Miss I. McLeish, typewriter.
Miss W. Westman, typewriter.
A. F. Purcell, messenger.
A. A. Ellement, messenger.

Division of Mineral Resources and Statistics:—

J. McLeish, B.A., chief of division.
C. T. Cartwright, B.Sc., assistant engineer.
J. Casey, assistant.
Mrs. W. Sparks, assistant.
Miss G. C. MacGregor, B.A., assistant.
Miss B. Davidson, typewriter.

Division of Fuels and Fuel Testing:—

B. F. Haanel, B.Sc., chief of division.
J. Blizard, B.Sc., technical engineer.
E. Stansfield, M.Sc., chemist.
A. H. A. Robinson, B.Ap.Sc., assistant engineer.

Division of Chemistry:—

F. G. Wait, M.A., chemist, chief of division.
M. F. Connor, B.A.Sc., assistant chemist.
H. A. Leverin, Ch.E., assistant chemist.

Ore Dressing and Metallurgical Division:—

G. C. Mackenzie, B.Sc., chief of division.
F. Ransom, B.Sc., assistant engineer.

Division of Metalliferous Deposits:—

A. W. G. Wilson, B.Sc., Ph.D., chief of division.
E. Lindeman, M.E., assistant engineer.

Division of Non-metalliferous Deposits:—

H. Fréchette, M.Sc., chief of division.
L. H. Cole, B.Sc., assistant engineer.
H. S. de Schmid, M.E., assistant engineer.

Explosives Division:—

J. G. S. Hudson.
NOTE.—*This division will be fully organized on the passage of the proposed Explosives Bill.*

Draughting Division:—

H. E. Baine, chief draughtsman.
L. H. S. Pereira, assistant draughtsman.
A. Pereira, assistant draughtsman.

OUTSIDE SERVICE.

Dominion of Canada Assay Office, Vancouver, B.C.:—

G. Middleton, manager.
J. B. Farquhar, chief assayer.
D. Robinson, chief melter.
A. Kaye, assistant assayer.
G. N. Ford, computer.
G. B. Palmer, assistant melter and janitor.

INTRODUCTORY.

One of the signs of the times is the increasing demand by the commercial and industrial world that the investigations of our mineral and metal resources shall be of a more practical and economic character. This demand was the primary cause of the establishment of the Mines Branch. And the fact that the general staff has increased from two in 1902, to the comparatively large and complex organization indicated in the foregoing classified list for 1911; the fact that the entire three floors of the commodious departmental building on Sussex street—when ready—will be filled; and the fact that 35,156 publications of a strictly technical and economic character were distributed during 1911, is cumulative evidence that the inauguration of the Mines Branch for the purpose of technologically investigating the metallic and non-metallic mineral resources of the country, was a wise departure, and has met a pressing public demand.

The programme of work mapped out each year is largely made in compliance wth urgent public requests and petitions for special investigations of ore deposits, etc., of promise, or to supply technical information of commercial value, bearing on industrial development. The Mines Branch is endeavouring to do the work the people are asking for, based upon numerous requests for information. This popular line of policy is dominant in Mines Branch procedure; because it is realized that the main objective should be the rendering of practical public service in the interests of the country.

For these reasons it is manifest that the work planned yearly must become increasingly comprehensive in scope: including as it does, the gathering of industrial statistics; investigation of ore dressing methods for preparing lean ores for the market, or smelter; laboratory research and analyses; magnetometric surveys of iron ore deposits; and general work in the field.

In accordance with the usual custom, this summary report is intended to furnish what is, of necessity, only a brief synopsis of the year's work. In addition to an account of the work carried on by the technical officers, reference is made to what may be considered as executive work, and office routine. Among the various synopses of work herewith submitted, it is difficult to single out any one particular paper as being of greater ultimate value than others. In some cases, however, more detail has been given regarding certain results, since the prompt publication of this technical data has been considered of more immediate value to the public.

The official programme of the Mines Branch for the past year was, to a considerable extent, a continuation of work previously begun. Such a condition is only natural, when the wide extent of the field covered by the Mines Branch is taken into consideration. For example, investigations dealing with wide-spread branches of the mining industry, such as the winning of building and ornamental stones, and the development of the iron, copper, and gypsum deposits of the Dominion: all of which are matters of very considerable magnitude. At the same time, the work of the past year has also been marked by the inception of certain new investigations.

It is, however, a matter of profound regret that, among the latter, it has not been found possible to include the establishment of a national explosives testing station. Attention has in the past been directed repeatedly to the imperative need for such a station, the undeniable value of which is now generally recognized by the mining and contracting public, and indeed by all those interested in the manufacture or use of explosives. In anticipation of definite action by the Government, and aided by the best expert advice, the necessary legislation—as embodied in the Explosives Act—was drawn up, and all necessary data secured. Owing, however, to an early dissolution of Parliament, action regarding this important matter was necessarily deferred.

It is earnestly hoped that the establishment of an explosives station, along the lines already suggested, will constitute a part of the legislation of the present session.

The investigation, having for its aim the establishment of a Canadian peat-fuel industry, and which has for some time been conducted by the Mines Branch, has now been practically completed. This investigation has demonstrated a process which is well adapted to the commercial manufacture of the peat fuel in Canada, and has resulted, moreover, in the creation of a market for such fuel. A practical recognition of the results of this work is already apparent, as evidenced by the active preparations at present being made by Mr. J. M. Shuttleworth and associates, for the manufacture of cheap peat fuel on a commercial scale, and on lines similar to those demonstrated at the Government peat plant, Alfred, Ont.

On pages 27-30 of this report, reference will be found to the establishment of a metallurgical research laboratory. As constituting one of the most practical forms in which departmental activity can find expression, the establishment of such a laboratory will undoubtedly commend itself to a large section of the mining public of Canada. Its possible value, direct as well as indirect, as applied to the metallurgical industry of this country, should amply justify any outlay that such work may involve.

Reference will also be found, elsewhere, to the important extensions which have been projected in connexion with our ore-dressing laboratory. Although little more than one year has elapsed since the work of this division was first inaugurated, the scope of its operations has already increased to such an extent as to demand the extensions referred to above.

Finally, it is a matter of very great satisfaction to be able to state that definite steps have now been taken to remedy the present inadequate office accommodation, which has in the past handicapped the efficient administration of the work of the Mines Branch. Owing to the impossibility of securing a building sufficiently commodious for the general work of the Mines Branch, the various divisions are at present quartered in five separate buildings, in various parts of Ottawa. With the constantly broadening scope of the economic work, the practical enterprises initiated, and the corresponding numerical increase in the technical staff, the inconvenience resulting from such decentralization may be readily conceived. Plans recently prepared, however, provide for the complete renovation, and fitting up for offices, of the building owned by the Dominion Government at the corner of George and Sussex Streets: which was formerly occupied by the Geological Survey Branch of the Department of Mines. It is expected that this building will be ready for occupancy sometime during 1912, and that ample accommodation will then be available, under one roof, for the entire staff of the Mines Branch.

The present year, as usual, has witnessed a large demand for the various technical publications of the Mines Branch, the total number of monographs, reports, bulletins, etc., distributed through the Post Office during the year being 35,156. Owing to this demand for copies of the various publications, editions are frequently exhausted in a very short time, thus requiring the printing of a second, and at times even a third, edition.

The total value of the mineral production for the year 1911 was $102,291,686; a decrease of $4,531,937 as compared with the preceding year. This decrease must be largely attributed to the long continued strike among the coal miners of Alberta, and the Crowsnest district in British Columbia. This strike not only seriously reduced the coal output, but, through the closing down of the Granby Smelter—on account of a shortage of coke—indirectly caused a smaller production of copper, silver, and gold.

The correspondence of the statistical division amounted to 7,727 communications received and sent; while the direct correspondence of my own office amounted to 6,307 letters received, and 4,696 letters sent.

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ALTERATIONS TO OLD GEOLOGICAL MUSEUM BLDG.
SUSSEX ST. OTTAWA ONT.
FOR DEPT. OF MINES.

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ALTERATIONS TO OLD GEOLOGICAL MUSEUM BLDG.
SUSSEX ST. OTTAWA ONT.
FOR DEPT. OF MINES.

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Fig. 3. New Headquarters of the Mines Branch

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ALTERATIONS TO OLD GEOLOGICAL MUSEUM BLDG.
SUSSEX ST. OTTAWA ONT.
FOR DEPT. OF MINES.

SECOND FLOOR PLAN

Fig. 4. New Headquarters of the Mines Branch

RECENT DEVELOPMENT OF ELECTRO-METALLURGY.

The present year has, in Canada, witnessed little progress in the development and application of the principles of electro-metallurgy as applied to the iron and steel industry. Indeed, at times it would seem that Canadian business men are inclined to be over-careful in accepting new methods of metallurgical treatment. They appear to be unwilling to try new methods of which the success has not been completely proven, and to lack that spirit of inquiry which, in European and American practice, is continually extending the limits of successful ore reduction.

In considering the development of the electric furnace, it should be remembered that such progress as has been made is of comparatively recent date. Thirty years ago the original Siemen's furnace was regarded almost as a scientific toy, and as being of little or no practical value. This was doubtless due, in part, to the wide difference which then existed between the cost of an electrical horse-power year, and its equivalent in coal. Conditions, such as the recent cheapening of electric energy on the one hand, and the steady advance in the price of solid fuel on the other, have, however, more nearly established the balance between these two factors.

In many of its applications the electric furnace has already safely passed the experimental stage; and although of comparatively recent date, its progress has been rapid and sure. In the production, for example, of high speed steel, the melting down of scrap metal, the production of certain ferro-alloys, and in its many other applications, it is no longer a question of demonstrating the reliability of the electric furnace, but a matter of engineering and finance. In 1905, there were very few electric furnaces, and these were of small capacity; while in 1910, sixty furnaces were either in use or under construction, some having a capacity of 15 tons. At the beginning of this period the value of the electric furnace rested more or less on such claims as were advanced by optimistic inventors. It is, however, to the engineer and designer, rather than to the inventor, that we must now look for the final adaptation of the electric furnace to commercial requirements. The following extract on the application of electro-metallurgy to commercial uses, is taken from "The Norse Power and Smelting Syndicate, Limited":—

"Though heat has played so great a role in human affairs, the problems of economy in the use of its available sources have been amongst the most difficult which have been presented for solution to engineers. Electrically generated heat appears at first sight to be the most extravagant conceivable, and this view is under many conditions correct. Electrical energy may, however, be converted into heat practically without loss, and hence, if the electrical energy is cheap enough, and if economy in its use can be effected, as is frequently the case, with greater ease than in the direct fuel furnace, it is capable of taking its place in the arts in competition with fuel as a source of heat. Moreover, the cost of electric heat is practically independent of temperature whereas the cost of heat from burning fuel increases as the temperature increases. The unit of work commonly used in connection with water power is the electrical horse-power year, which may mean either one horse-power operating for a year, 365 horse-power operating for a day, or any other power operating for a corresponding period.

The heat obtainable from this is equivalent to that got by burning about 14 cwts. of high class British coal. A direct comparison of the costs of one horse-power year and of 14 cwts. of coal is, however, unfair to the former, as the conditions under which the heat is produced are so unlike; electric heat is under better control than fuel generated heat, and the losses in its application are smaller and of a different character.

An example of the economy to be effected electrically is that of the production of crucible steel. A Sheffield crucible steel furnace does not utilize more than 2 per cent of the heat in the coal with which it is fed, and the heat necessary to be applied to an electric steel refining furnace doing exactly the same work is about one twenty-eighth part of that supplied to the crucible furnace. No laboured argument in favour of the electric furnace in such a case is necessary, and slow as the steel trade is to adopt new methods and processes, the electric steel furnace has now become recognized as a practical and economical apparatus in Europe and America.

A second application of electric heat in the iron industry is the production of iron and steel direct from ore. Experiments have been going on for some years in Sweden, Canada, and California, and recently the results have been so favourable that the Swedish Jarnkontoret, probably the best informed institution in the world on the subject of the production of high class iron and steel, has given financial support to a works in course of erection for the industrial exploitation of the process."

In the conditions affecting the production of iron and steel in certain parts of Canada, there is a resemblance to those of Norway and Sweden. In each case there is a scarcity of coal and coke, but an abundance of cheap water-power. In Norway and Sweden the development of the electric furnace promises to re-establish the iron industry—which a scarcity of fuel had almost destroyed. During the past two years, considerable work of an experimental nature has been carried on in Sweden under the auspices and direction of the Jarnkontoret. This association voted $90,000 toward the building of a 2,500 H.P. electric furnace for iron smelting at Trollhättan; and to further assist the undertaking, power was furnished by the Swedish Government at very low rates. A description dealing with the construction and operation of this furnace, as well as with the results obtained, has recently been written by Mr. T. D. Robertson. After describing the general design and arrangement, the writer considers the actual operation of the furnace as follows:—

"The furnace was thoroughly dried out with wood and charcoal fires, and heated up electrically by filling the hearth with coke and turning on the current. Charging was commenced on November 15, 1910. The furnace began to produce iron regularly and without difficulty, the first few tappings being rather high in sulphur from the large quantity of coke in the hearth.

The various iron works of Sweden sent their ores to be electrically smelted. In order to gain as much information as possible, the burden of the furnace was constantly altered to vary the grade of iron produced. Such treatment involving the frequent alternation of acid and basic slags was not good for the furnace hearth, and it must be admitted that it was something of an achievement for this to stand six months of this treatment without needing any serious repairs.

OPERATING RESULTS OF ELECTRIC IRON SMELTING FURNACE.

Periods of Operation.	2.	3.	4.	5.
Per cent iron in ore	65·57	65·06	49·50	57·92
Per cent iron in charge	62·1	62·56	42·42	53·06
Slag per ton (2,000 lb.) of iron, lb.	410·00	448·00	1,560·00	916·00
Material charged per hectolitre of charcoal, lb.	146·3	156·5	198·7	153·7
Time consumed in working, hr.	2,010·00	184·5	639·3	506·5
Time consumed in interruptions, hr.	105·6	5·00	21·00	22·2
Average load, kw.	1,319·00	1,694·00	1,017·00	1,733·00
Kw.-hr. per ton of iron	2,087·00	1,953·00	2,384·00	2,403·00
Iron per kw.-yr., tons	4·2	4·49	3·67	3·64
Electrode consumption, per ton of iron, lb.	22·48	21·68	18·38	14·9

Period No. 1 covers the firing up of furnace on November 15, 1910; per cent of iron in ore, 64·92; per cent of iron in charge, 59·8; slag per ton of iron, 780 lb.; time consumed, 7 hr. 50 mm.; average load, 1,121 kw.; kw.-hr. per ton of iron, 3,454; iron per kw.-yr., 2·54 tons.

The conditions governing the grade of iron produced are similar to those in the ordinary blast furnace, except that the irregular influence of the air blast is absent. The furnace gives the maximum output when making white iron, as the making of grey iron requires a rather higher temperature and consequently a greater power consumption. By increasing the amount of ore in the charge when the furnace is making white iron, a low carbon iron with very little silicon is produced, a typical analysis of which is as follows:—

	C.	Si.	Mn.	S.	P.
Percentages	2·60	0·10	0·11	0·02	0·01

This iron naturally is full of holes, but instead of these having coloured oxidized surfaces, they are silvery white; the absence of oxygen from the furnace atmosphere accounting for the production of this grade of iron free from oxides. The results of making steel from this iron are given later.

A point of interest is the success met with in smelting magnetic concentrates at Trollhättan. The design of shaft in this particular case is not considered suitable for the purpose, being too narrow, but in spite of this, 65 per cent of finely divided concentrates caused no inconvenience in working. The inventors of the furnace are of the opinion that, with a specially designed shaft, charges of all fine concentrates could be smelted. Canada is rich in deposits of iron sands and lean magnetites, which are easily concentrated, but which are expensive to nodulize or briquette into a form suitable for blast-furnace smelting, so that

where these are within easy reach of water powers, there seems to be a good field open for electric smelting.

Dr. Haanel, in his report on the experiments made at Sault Ste. Marie, mentions that no difficulty was experienced in smelting titaniferous ores electrically, and it is interesting that the Swedish experience bears out this point, although no ores were used with more than ·08 per cent TiO_2. The electric smelting of ores with high sulphur content is another interesting problem. Dr. Haanel was successful in producing low sulphur iron from sulphurous ores, but in Sweden there are practically none of these ores mined, so that this point was not confirmed on a large scale at Trollhättan; however, there can be little doubt that the electric furnace, with its reducing atmosphere and basic lining of the hearth, permitting as it does of the use of slag very rich in lime, offers the best method of producing sulphur-free pig iron from ores containing that unwelcome element.

The pig iron produced by the furnace was sent to various Swedish iron works for conversion into steel in open-hearth furnaces. The characteristic feature of electric pig iron is its freedom from oxides; and in consequence electric pig of normal silicon content (say, 1 per cent and over) takes a longer time and more ore to convert into steel than ordinary blast-furnace grey iron. Low-carbon electric pig iron, however, is found to give surprising results, charges made up of 50 per cent of this iron and 50 per cent of scrap producing hot fluid steel with considerable saving of time over ordinary practice. As was to be expected, the open-hearth furnace managers looked somewhat askance at this iron at first, as they knew the disastrous effect of using low-carbon iron full of holes from the blast furnace; however, after giving it a trial the workmen asked for more, as they said that the furnace worked better and more rapidly with the new pig iron. Fortunately for the electric furnace in Sweden, it is more economical to make the white iron that the steelmakers prefer than to make high-silicon grey iron. Thus it may be maintained, on the strength of the experience gained, that for the open-hearth process, high-silicon contents are detrimental rather than advantageous, while in the blast furnace pig iron a certain quantity is necessary to neutralize the defects of a reduction process less perfect and ideal than that employed in the electric furnace."

These results appear to indicate that the electro-thermic process for smelting purposes, has now passed beyond the experimental stage, and that the use of the electric furnace, in the production of pig iron, will, in the near future, supersede the present charcoal furnaces in Sweden. It may be further added, that at the present time there are eight Grönwall reduction furnaces, having an aggregate of 25,000 H.P., in operation, or in course of construction. In addition, the construction of other furnaces having an aggregate of 36,000 H.P., has been projected.

PROGRESS OF PEAT FUEL INDUSTRY.

The possible future of peat, as an asset of economic value to the Dominion, has, for several years, in the laboratory as well as in the field, been the subject of systematic investigation by the Mines Branch of the Department of Mines. That the tests which have been carried out have met with public approval, is evidenced by the wide-spread interest with which the investigation has been followed. The recent successful termination of this work has already been recognized by active preparations for the development of our peat resources by private enterprise along purely commercial lines. Commenting on this fact, the *Ottawa Citizen,* in its issue of November 15, 1911, remarks:—

"The Alfred Peat Plant is not only at the present time furnishing Ottawa with fuel, but has met with recognition by those best qualified to judge. It is already bearing practical fruits in the establishment of commercial plants, which was, after all, the primary object of the Department."

The fact that the central provinces of Canada possess no deposits of coal, added to the rapidly decreasing supply of wood, renders the use of these fuels prohibitive in many localities, and constitutes a condition that might, under certain circumstances, lead to alarming results. At present, Ontario and Quebec rely largely for their coal supply—not only for domestic but for steam purposes also—on importations from the United States. This coal is obtained from year to year, but no provision is made for such contingencies as would be presented through a stoppage of the supply.

It was in large measure through the consideration of conditions such as these, that attention was first directed to the potential importance of the abundant supplies of peat known to exist in various parts of the central provinces.

Prior to 1906, many attempts had been made, not only by private individuals, but also by incorporated companies, to place on a commercial basis the manufacture of raw peat into marketable fuel. These attempts were prosecuted persistently by some, and in a desultory manner by others; but, owing to various causes, all resulted in absolute failure, and in financial losses which were said to aggregate over $1,000,000. It may be added that, in each case, this want of success must be largely attributed to failure to adopt economic methods in reducing the very large percentage of water contained in the crude peat. Some experimenters resorted to artificial means of drying; while others endeavoured to remove the excess water by means of powerful presses. As already stated, neither of these methods proved successful; and it is now recognized that, in actual practice at the present time, both are absolutely impracticable and uncommercial.

In 1907, the men who had until then endeavoured unsuccessfully to solve the problem of commercially manufacturing peat fuel, appealed to the Government for assistance, and as a result of this appeal the attention of the Mines Branch was directed to a systematic study of the question. The aims of the investigation were, in brief:—

(1) To investigate the peat resources of Canada as to the depth, quality, and suitability of the individual peat bogs for fuel and other purposes.

(2) To actually demonstrate a process that is in successful operation in Europe.

(3) To demonstrate the economy effected in the production of power by gas producers adapted to the use of peat as fuel.

(4) To interest capital in the further development of the peat industry, and to create a market for peat.

In initiating this investigation, and in order to prevent the expenditure of money on processes which had long ago proved to be failures, advantage was taken of those results which present European practice had evolved, after half a century of experiment and research. A member of the Mines Branch staff was, therefore, commissioned to make a careful examination of the various processes and types of plants in use in the various northern European countries. Conditions governing the production of peat in these countries were compared with the conditions existing in Canada; and, based on the conclusions deduced from these observations—taking warning from the failures, and benefitting by the successes of European manufacturers—the experiments by the Mines Branch were begun.

For purposes of practical demonstration, a portion of a peat bog was purchased near Alfred, Ont., and on this bog a small peat manufacturing plant was installed. This plant represents the most economic and progressive European process—the wet process for manufacturing air-dried machine peat—and 1,300 plants of this type have up to the present been installed in Sweden and Russia. Subsequently, as the final step in the investigation, a 60 H.P. peat gas producer and gas engine were installed to demonstrate the economic production of power by this means.

Relative to the peat manufacturing investigation into the possible future of the peat industry in Canada, the references and data contained in this annual report will probably constitute the final chapter as far as the Mines Branch is concerned. The work which this Department has conducted during the past four years, has afforded a practical demonstration of the detailed working out of the method best adapted for use under Canadian conditions, and has shown:—

(1) That the production of air-dried machine peat is the cheapest and most practical method of manufacture;

(2) That by utilizing mechanical excavators, and manufacturing on a commercial scale, peat fuel for local use, or for use within reasonable distance of a bog, can successfully compete with anthracite coal.

(3) That for power purposes it has been demonstrated that peat is a most admirable fuel, and, as compared with bituminous coal, can be used with greater economy in the gas producer. The above statement is based on peat at approximately $2 per ton, and bituminous coal at $4 per ton.

In recognition of what has been accomplished toward the development of a peat fuel industry, the Conservation Commission of Canada, at its third annual meeting, held in Ottawa, passed the following resolution: "That the Commission of Conservation approves of the investigation that has been carried on by the Mines Branch of the Department of Mines in connexion with the commercial use of peat, and suggests that further investigations and experiments be made with a view to making the proposition still more attractive to the people."

It now, therefore, remains for private enterprise to place the production of peat on a purely commercial basis; for in interpreting such results and cost data as have from time to time been published by the Mines Branch, due consideration must be given to the fact that, the work has been partly demonstrative and partly experimental, and has, moreover, been carried out under Government auspices, and by trained technical officers. Under such circumstances, primary importance cannot always be given to commercial considerations. Hence, we must look to private enterprise, operating on a commercial scale, and along strictly commercial lines, to further supplement and confirm what has already been demonstrated. In the following letter, recently received from Mr. J. M. Shuttleworth, of Brantford, Ont., this fact has been recognized:—

"Dr. Eugene Haanel,
Director of Mines,
Mines Branch, Department of Mines,
Ottawa.

Dear Sir,—

Speaking for myself, and I feel that I am voicing the sentiment of many people, your department and yourself personally, deserve great credit for having shown that the manufacture of peat fuel is practicable in Canada. You have blazed the way, and it is now up to us to show its commercial possibilities."

Mr. Shuttleworth has already formed a company who have carefully examined, through their own engineers, the process employed at the Government plant at Alfred. These experts have measured the excavations, assured themselves of the output, questioned the workmen, and have come to the conclusion that this process is the most practical one in use to-day. In consequence of this examination by Mr. Shuttleworth and his engineers, the Department has been petitioned to permit the Company to install on the Alfred peat bog next spring (1912), and at their own cost, a plant in which the partial hand labour of our appliances will be replaced by machinery and power. This request has been granted by the Department, and the order for the machinery to be employed has been given. It is fully expected, therefore, that in June, 1912, a plant of 10,000 or 15,000 tons capacity will be in operation.

During the past season, operations were continued at the Alfred bog, resulting in the production of 2,100 short tons gross of peat, during a period of 93 days. Making allowance for waste and for fuel used in the plant, the net amount available for other uses was 1,800 short tons. Of this amount about 1,200 tons were sold, a large portion being shipped to various points by rail. The remainder has been stored in stacks at the bog for use at the Government Fuel Testing Station, Ottawa.

In addition to this practical demonstration work, the examination of peat bogs, in various parts of Canada, was continued. In all, some 20 bogs were visited: 17

being situated in the Province of Manitoba, and the remainder in the Province of Ontario. Descriptions of these bogs, with illustrative maps, will be found in the detailed report dealing with this subject.

FUEL TESTING STATION, OTTAWA.

Reference was made in the Summary Report of 1910, to the installation of testing appliances and machinery at the Fuel Testing Station recently established at Ottawa, by the Mines Branch. The idea embodied in a plant of this kind is not a new one; for its economic value has long been fully acknowledged by the Mining Bureaus of other progressive Governments. Fuel testing stations or laboratories in England, Germany, France, and the United States, are, to-day, recognized assets of national importance.

The aim of such fuel testing plants is, to demonstrate in a thoroughly practical way, and by actual tests, the manner in which the various fuels, such as coals, lignites, and peats, may be most efficiently and economically applied to the development of power. To appreciate this fact, one has only to consider the wide variation in the physical properties, and chemical composition of any series of coals, even when mined in the same locality. Failure to recognize this principle can only result in low efficiency in the generation of power, and in a waste of fuel which, in the aggregate consumption of a manufacturing community, becomes a matter for serious consideration.

Generally speaking, the work of a fuel testing station is to determine the commercial possibilities of fuels, by classifying them according to their chemical analyses and heating capacity; to ascertain their amenability to mechanical purification, *i.e.*, washing; their suitability for the manufacture of coke, and finally, their adaptability for steaming purposes. The investigations to be carried on by the technical staff in the immediate future will include:—

(1) An examination of samples of shipping coals, anthracite and bituminous, from operating mines, and from newly opened deposits. Similarly, the lignites found in the Provinces of Alberta, Saskatchewan, and Manitoba, will be investigated, as to their suitability and value for the generation of steam, and for the production of power by means of the gas producer and gas engine, and

(2) Investigation of the coals imported from the United States: as regards their suitability and value for steaming and producer gas purposes.

Since by far the greater part of the coal used in the Province of Ontario is imported from the United States, any economy which may be effected through more economical methods of utilization will mean a large reduction in the amount of foreign coal imported, and, consequently, a large saving in the amount of money leaving Canada.

The method commonly employed for converting the potential energy of coal into useful work is, by burning the coal under a steam boiler, and then expanding the steam generated thereby, in a steam engine or steam turbine. This method, except in the operation of the largest and most elaborately constructed plants, is exceedingly wasteful when compared with the economy which may be attained by the use of a producer gas plant. It is, therefore, hoped that the present investigation into the behaviour of the different coals in gas producer plants, will result in a marked economy in the development of power.

The results of investigations, made along the above lines by the Fuel Testing Division of the Bureau of Mines of the United States, have proven to be of specific importance to those States, which, like Ontario, are comparatively remote from coal supplies; or which have only low grade coal, lignite, or peat. In the New England States, for example, the rapid industrial development has made

the coal problem an important one, since the question of a fuel supply in that section of the United States is similar to that of the middle provinces of Canada: their coal supply being obtained from Pennsylvania, and the Virginias, while a small amount is imported from Canada. Consequently, the manufacturers of New England have to pay for transporting their fuel from distant coal-fields, and still compete with manufacturers who have coal at their doors. This condition has led to a general discussion of the coal problem in the New England States, and even to the appointment of committees of manufacturers to consider means of relief.

The following quotation from Bulletin 13 of the United States Bureau of Mines: "Resumé of Producer-Gas Investigations" will show the great value of such investigations to large users of coal for industrial purposes:—

"The investigations made by the United States Geological Survey and the Bureau of Mines, indicate that marked economies can be gained by a general use of the gas producer in New England, and moreover, that these economies will be sufficient to overcome the handicap placed on the industries there by coal transportation charges. In 1902, the coal consumed to produce steam power for manufacturing purposes in the New England States cost approximately $50,000,000, and the annual fuel bill of these states now approximates $100,000,000. The development of this power through the more efficient method suggested by these investigations would mean a yearly saving of many millions of dollars."

In order to carry out the proposed research work, it is purposed to install a commercial steam boiler equipped for experimental work in that part of the fuel testing station, at present occupied by the ore concentrating laboratory. Provision is made in the plans which have been prepared for this extension of the fuel testing plant, for a chemical laboratory sufficiently large to accommodate a staff of chemists. The duties of this staff will be to make chemical analyses and to determine the heating value of the various samples of coal, lignite, and peat collected from the various operating mines of Canada, and also of the coals imported from the United States. Large samples of these coals, lignites, and peats will be tested:—

(1) For their value for steaming purposes when burned under a steam boiler.

(2) As to their value for the production of power when used in a gas producer.

The results of these investigations will be published in bulletin form, as soon as convenient after the completion of the tests, and distributed to those interested.

In view of the fact that the Dominion Government is yearly increasing its purchase of coal for supplying the various departments, government railways, and ships of the newly created navy, it is of great importance that the Government be placed in a position to purchase this coal on an economic basis. With a view to assisting the Government in this matter, *i.e.*, in the drawing up of technical specifications which will ensure the delivery of the particular kind and quality of fuel contracted for, it is further proposed to extend the scope of the work outlined above by including the sampling, chemical analyses, determination of heating value; and, whenever desired, the testing for steam purposes, of all the coals purchased by the Government. This will necessitate a considerable increase in the technical staff at present employed, in order to include technical officers qualified to collect representative samples at the mines of the fuel purchased, and at the same time, necessitate additional assistance in the chemical laboratory for making chemical analyses.

The work of the Fuel Testing Division for the current year has, for the most part, been carried out along lines of investigation very similar to those followed during the previous year. Numerous tests were made in the Körting gas producer plant, for the purpose of determining the economic value, and commercial adaptability of peat procured from bogs in Ontario and Quebec. In the operation of the Körting gas producer, considerable difficulty was at first experienced owing to defective design. As a result, much of the tarry distillate was carried past the gas cleaning system, and, being redeposited in the engine, interfered with the operation of the

plant. On this matter being referred to the manufacturers, the producer was at once overhauled, and the defect partially remedied under the direction and at the expense of the Körting Brothers. These alterations in the producer, together with modifications of the gas cleaning system subsequently devised by Mr. B. F. Haanel, have resulted in the plant giving entire satisfaction. Moreover, using the Körting producer, it has been demonstrated by means of a series of exhaustive tests, that on the bog, peat fuel at $2 per ton can successfully compete with bituminous coal at $4 per ton. An illustrated report, giving complete results and all necessary data relative to the above investigation, is now in the press, and will be issued shortly.

A recent addition to the Fuel Testing Station, consists in the installation of a Westinghouse double zone bituminous suction gas producer of 125 H.P. capacity. This producer is adapted for the use of all kinds of bituminous coals and lignites. The fuel testing plant of the Mines Branch is now, therefore, in a position to determine on a commercial scale, the relative value of all varieties of peat, lignites, and bituminous coals, when used in gas producers for power development purposes.

Gas analyses, and other determinations involved in the above tests, have been made in the chemical laboratory connected with the fuel testing station, by Mr. Edgar Stansfield.

During the field season of the present year, a careful study of a large number of peat bogs situated in the Provinces of Ontario and Manitoba, was made by Mr. A. Anrep, Jr. The manufacture of peat at the Government bog at Alfred was also resumed, under the supervision of Mr. Bengtsson. The season's operations at this bog resulted in the production of 2,100 short, gross tons, during a period of 93 days; or an equivalent of 1,800 short tons of peat containing 25 per cent moisture. A portion of this output was disposed of in Ottawa, Montreal, and in the vicinity of Alfred. The remainder was reserved for use at the Fuel Testing Station, Ottawa. Cost data relative to the above operations will be given in a bulletin to be issued during 1912.

Interim reports by Mr. Anrep, and by Mr. Stansfield, will be found in connexion with the report of the Chief of the Fuel Testing Division.

ORE DRESSING AND METALLURGICAL LABORATORY.

During the current year, general approval of the purpose and work of the ore dressing and concentrating laboratory operated under the direction of the Mines Branch, has been expressed by the mining public. The conditions which appeared to require the establishment of such a laboratory, as well as the results which it was hoped would be attained, were referred to in the Summary Report for 1910.

A scarcity in the domestic supply of high grade iron ore on the one hand, and extensive, but as yet undeveloped deposits of low grade iron ore on the other, may, in a word, be considered as among the chief conditions which, to-day, confront the Canadian iron masters, and which determine the output of Canadian furnaces. By concentration of our low grade ores, and by the elimination of such impurities as sulphur, phosphorus, and titanium, when present in excess, it is hoped that large iron deposits, which up to the present time have been considered as of little or no value, may become profitable sources of supply for our own blast furnaces.

During the year just closed, trial shipments of low grade iron ores were received from Robertsville, Goulais river, and Culhane, in the Province of Ontario; from the Natashkwan river in the Province of Quebec; from the Gloucester iron deposits in the Province of New Brunswick, and from the Nictaux-Torbrook deposits in Nova Scotia. By means of the Gröndal magnetic separation system, tests of these ores, relative to their adaptability to concentration and purification, were carried out under conditions which approximated, as nearly as possible, those required by commercial

practice. A sample of nickeliferous pyrrhotite from a deposit near Nairn, Ont., was also tested, with a view to determining the treatment best adapted for extracting the nickel and copper content.

The above work was carried out in the ore dressing laboratory of the Mines Branch under the direction of Mr. G. C. Mackenzie; and detailed results, as well as an outline of methods employed, will be found in his report. In addition to this work Mr. Mackenzie also spent a part of the field season in a systematic examination of the deposit of iron-bearing sands lying along the north shore of the St. Lawrence, near the mouth of the Natashkwan river. Previous investigations, carried on at various times by different people, resulted in a considerable divergence of opinion regarding the possible economic value of these sands. The enormous deposits which are known to exist, not only on the Natashkwan, but along the lower St. Lawrence, also, render the accurate determination of their probable value a matter of considerable importance. Consequently, a report of Mr. Mackenzie's investigations in the field, and of the subsequent concentration work in the laboratory—of a shipment of the iron-bearing sands—will be read with interest. It appears, however, that further investigation will be required to finally determine the commercial value of these deposits.

The work of the ore dressing laboratory has, during the past year, been considerably handicapped owing to insufficient accommodation; but contemplated alterations in the plant will, it is expected, greatly improve conditions in this respect.

INVESTIGATION OF PROCESSES FOR THE REDUCTION OF REFRACTORY ZINC ORES.

In the Summary Report for 1910, the attention of the Government was called to the desirability of instituting an inquiry into modern processes for the extraction of zinc from refractory ores. At that time ample evidence was presented establishing the undoubted benefit that such an investigation, if successful, would bring to the zinc mining industry of Canada, particularly in the Province of British Columbia. In the report of the Zinc Commission, page 47, Mr. W. R. Ingalls said: "All things considered, it is probable that 15,000 tons of zinc ore of 50 per cent grade would be a liberal estimate for the productive capacity of the Slocan." Mr. Philip Argall considered that the mines of Ainsworth camp could produce from 16,000 to 30,000 tons of zinc ore per annum, which estimate, in the opinion of Mr. Ingalls, was "extremely liberal." Taking the lower figure for Ainsworth camp, there was thus indicated a possible production of about 30,000 tons of zinc ore per annum in British Columbia. However, its mines have never yet attained any such figure, their actual output in 1908 having been only 7,000 tons, Ainsworth camp not yet having become a producer at all.

This unsatisfactory condition of the industry is largely due to adverse operative and transportation conditions. Costs of production are relatively high, and the product must be shipped to smelters in the United States and Europe, in the former case being obliged to meet a hostile tariff duty and stand a long haul; and in the latter case being obliged to stand a still longer haul. These conditions have particularly delayed the beginning of zinc ore production in the Ainsworth district, where it has been found impossible to raise the grade of the zinc concentrate sufficiently high to withstand the charges.

The zinciferous ores of British Columbia are in no wise different, broadly speaking, from ores existing elsewhere, but their exploitation is rendered difficult by their remoteness from the Eastern and European markets and by various economic conditions that exist in the Rocky Mountain regions as above remarked. The problem that confronts the zinc industry of British Columba is consequently the discovery

or development of some metallurgical improvement of an extent sufficient to offset these adverse conditions. Several local undertakings, conducted privately at the expense of large sums of money, having failed, the zinc producers of East and West Kootenay appealed for assistance to the Department of Mines.

In answer to this appeal, the sum of $50,000 was, in 1910, voted by the Dominion Government "for investigating processes used in the production of zinc; for making experiments and for any other purpose that may be deemed advisable for the promotion and manufacture in Canada of zinc and zinc products from Canadian ores." Thereupon, instructions were issued to Mr. W. R. Ingalls of New York, authorizing him "to inaugurate and carry through an investigation for the discovery or development of some method for the economical treatment of the mixed zinc sulphide ores of Canada, in the production of metallic zinc or a marketable zinc product." The following report, recently received from Mr. Ingalls, summarizes the results of his investigation up to the present time:—

COPY.

WALTER RENTON INGALLS, 505 Pearl Street,
NEW YORK, August 23, 1911.

DR. EUGENE HAANEL,
Director of Mines,
Ottawa.

Dear Sir,—In compliance with your request for a report upon the progress of the zinc investigation now being conducted by the Department of Mines, I beg to present the following:—

The general plan of the investigation was fully outlined in my report to you under date of January 28, 1911, to which I beg to refer you. Since that time work has been prosecuted, especially in the field of electric smelting, this being done in the metallurgical laboratory at McGill University, Montreal, under the immediate direction of Dr. Alfred Stansfield. A large number of experiments have been made with several forms of furnaces, certain of which have been of rather elaborate construction, and with a variety of raw material.

Our early experiments were directed chiefly toward a discovery of the metallurgical conditions that have heretofore prevented a satisfactory condensation of zinc as molten spelter. While I cannot say that these experiments have afforded us a complete explanation of those conditions, they have taught us a good deal, but in spite of the knowledge acquired, we have been so far unable to master the difficulties.

We have indeed produced some small quantities of spelter, and in certain experiments have condensed a fairly large proportion as molten metal, but we have not yet been able to do that at will.

Our experiments have thrown light upon the principles of furnace design and have led us to condemn several types that we have tried. Our work has indicated that in order to achieve any material improvement over the ordinary practice of zinc smelting, it is necessary to abandon certain features of the latter and contemplate continuous charging of the ore and reduction material and discharging of the residuum without interfering with the process of distillation. These conditions introduce a multitude of perplexing difficulties that can be worked out only by tedious experimentation.

At the request of the Secretary of the Canadian Mining Institute, and with your permission, I presented at the meeting of the institute in Quebec, in March, 1911, a paper on 'The Problem of Mixed Sulphide Ores,' a copy of which I attach to this report, that concisely summarizes the state of the art in the treatment of such ores, and the natural obstacles that block procedure in certain directions.

A careful scrutiny of the work on the treatment of such ores that is being done by other metallurgists and investigators has been maintained, and I have examined numerous proposals that have been presented with more or less detail, both through your office and to me directly; but I have not discovered anything save one that in my opinion holds out any promise of successful adaptation to the conditions existing in British Columbia. I am conducting correspondence respecting this, but as to inaugurating experiments upon it, I am disposed to hold them in abeyance pending further progress in our electric work.

I regard the electric work as being of particular interest as an exploration in a virgin field of unknown possibilities. Doubtless with the same idea a great deal of work in this field is being done by numerous investigators in both Europe and America. I have been informed within a few weeks, that there are now two electro-thermic zinc smelters in operation in Scandinavia, viz., one in Trollhättan, Sweden, using about 7,000 horse-power, and one in Sarpsborg, Norway, using about 4,000 horse-power. Operations at these works were inaugurated five or six years ago, but, according to my information, the results were for several years commercially unsatisfactory, and it is only recently that it has been claimed to have become possible to make spelter from ore upon an industrial scale. The companies operating these works maintain absolute secrecy respecting them, and I have not been able to learn any details as to their operations.

Apart from the work in Scandinavia, as to the commercial success of which no information is available, the electric smelting of zinc ore is, in spite of all claims to the contrary, not only still in the experimental stage, but is in the infancy of the experimental stage. Even if the metallurgical difficulties can be overcome, which is possible, I am of the opinion that no one, except perhaps the Scandinavians, is yet in a position to make any reliable estimate of commercial advantage or commercial results in any way. It is, however, well worth while to determine the possibilities and publish the results for the general benefit, unveiling so far as possible the secrecy that is likely to be maintained as to investigations in this field by private interests, having always in mind, of course, the hope that our work may develop a process that will be commercially applicable to the treatment of the zinc ores of Canada.

Respectfully submitted,

(Signed) **W. R. Ingalls.**

EXPLOSIVES DIVISION.

The need of a bill, authorizing the regulation—under Federal authority—of the manufacture, testing, importation, transportation, and storage of explosives in Canada, was more evident than ever during 1911.

The frequency of disasters—many of them of a preventable nature—which accompany the use of explosives in Canada to-day, cannot but impress the most casual observer of current events. The reports of the deplorable accidents that appear from time to time in the daily press, are sufficient to demand serious consideration; but the evidence annually presented in the statistical returns compiled by the Mines Branch, and the Provincial Bureaus, demands aggressive action. Therefore, realizing this to be the case, a representative of the Mines Branch was, early in 1909, commissioned to investigate existing conditions in Canada.

In 1910, the conclusions set forth in this thoroughly technical inquiry and investigation, assumed tangible form in the drafting of a Bill for regulating the manufacture, testing, importation, and storage of explosives in Canada. The aim of this proposed legislation was, to provide:—

(1) That as a result of placing all inspection and testing under Federal authority, explosives manufactured in Canada shall reach the standardization and consistency specified in the proposed Explosives Act.

(2) That after the passing of the Explosives Bill, all explosives imported into Canada shall comply with the specifications and tests indicated in the same.

The official testing of explosives at the Government Station at Ottawa, would thus raise the standard of manufacture; while the publication of the results of the regulation tests to which explosives must be submitted, would enable miners, contractors, and others, to intelligently determine the adaptability of certain explosives to specific uses under definite conditions.

The proposed Bill for regulating the manufacture, testing, importation, and storage of explosives in Canada, was formulated by the Mines Branch: acting in conjunction with the Department of Justice. This Bill went into Committee of the House of Commons on the 4th of May, 1911. It was discussed, clause by clause, and passed up to, and including, section 11: these being the most important of the twenty-five clauses contained in the Bill. Owing, however, to the dissolution of Parliament, early in July, the Explosives Bill was allowed to stand over, and has not, as yet, been taken up during the present year.

The necessity for an Explosives Act in the Dominion is manifest, and needs little comment. In adopting such a measure, Canada is following the example already set by practically every other progressive Government. In 1875, Great Britain passed an Act (38 Victoria, C. 17) to regulate the manufacture, importation, transportation, storage, and testing of explosives. While this Bill was originally concerned chiefly with the manufacture and handling of gunpowder, it has from time to time been so amended, as to include the wide range of high explosives which have subsequently been invented. Incidentally, it may be regarded as a significant fact, that the

Explosives Act of Great Britain has, during the past twenty-five years, formed the basis of similar legislation by all the European countries, as well as by South Africa, India, New Zealand, Egypt, and the Commonwealth of Australia.

Regarding the extent to which explosives are manufactured in Canada, we have no definite knowledge. Manufacturers are, at present, under no obligation to furnish statistics as to their output, the number of their employes, or the number of accidents, that occur. It may be added that, in no other country where mining and construction work is carried on to the extent that it is in Canada, does such a state of affairs exist to-day.

Canadian Customs returns indicate that, during the fiscal year ending March 31, 1911, 913,498 pounds of explosives of all classifications were imported into this country. At the present time, all these explosives—with the exception of those on the authorized and permitted lists of Great Britain—are allowed to enter Canada, and are placed in the hands of the users without having been previously submitted to any Government test as to their adaptability, chemical composition, and standardization of stability. This absence of Government supervision is, in the case of Canada, still further emphasized, when we consider the important factor of extreme climatic conditions of heat and cold, and its well-known effect on nearly all classes of explosives.

There is little doubt but that such a state of affairs is, in no small degree, directly responsible for many of the disasters resulting from the use of explosives. To more fully realize the truth of this, one has only to read paragraphs such as the following quotations taken from the Annual Report of the Ontario Bureau of Mines for 1910 and 1911. The author of these extracts is Mr. E. T. Corkill, Chief Inspector of Mines for Ontario:—

"There were last year in all twenty-four fatalities caused by explosion or from gases, or 49 per cent of the total fatalities. There is no country that publishes accurate statistics where the accidents from explosives constitute so large a percentage of the total number."—Ont. Bureau of Mines, 1910, p. 59.

"The necessity for an inspection of explosives, which can only be instituted by the Dominion government, is clearly proved by the death rate due to their use, not only in Ontario but throughout Canada."—Ont. Bureau of Mines, 1910, p. 58.

" There were sixteen fatalities resulting from the use of explosives underground and two on the surface, a total of eighteen men killed There were thirty-six men in all killed at the mines, so that explosives were responsible for 50 per cent of the fatalities. In 1910, there were ten men killed by explosives at the mines, or 27 per cent of the total number killed. It is, therefore, evident that there has been an increase of nearly 100 per cent in the fatalities from this cause.

"This condition is a matter for regret and also for censure when, on an analysis of the fatalities, we find that at least half of the accidents was the result of carelessness. In the greater number of accidents from explosives there are generally only two factors. The first is the condition of the explosive, and the second the care with which it is handled. The first cause is one over which the Inspector of Mines has but little control, and has no facilities for acquiring such control. There has never been in Canada any legislation dealing with the inspection of explosives, which is a matter coming within the jurisdiction of the Federal government. At present any one who has a substance that will explode may sell it, if he can get a buyer. Before the quality of the explosive is proven accidents may result. It is not only the small dealer who needs inspection, but also the large producers. In the competition for making sales and the desire for large profits, the grade of the explosive may not be kept up to the standard. Improper mixing, improper proportion of ingredients, improper packing, all tend to render the explosive unsafe and to increase the accident rate. Old explosives that have been in storage for more than a year are sometimes shipped into the less accessible camps in the winter time, and have to be used by the mining companies during the summer, as no others can be obtained. When an accident occurs now from an explosive, there is no way by which this explosive may be thoroughly tested, to ascertain wherein the fault lies."—Report on Mining Accidents in Ontario, 1911, p. 8.

As a result of the above consideration of the imperative need for adequate Government supervision, plans have recently been prepared for a Chemical Explosives Laboratory, which, when erected, will constitute the main building in connexion with the Explosives Testing Station of the Explosives Division of the Mines Branch. These plans, designed by Messrs. A. Dupré and Sons, chemical advisers to the Explosives Department of the Home Office, Great Britain, provide for a main laboratory 75 feet long × 35 feet wide. In this building, provision has been made for

a heat test room, balance room, gas analysis room, furnace room, extraction room, nitrometer room, physical test and research room, and spectroscope room; where complete chemical, as well as certain physical tests will be applied to explosives. In design, in equipment, and in the apparatus provided, it is confidently anticipated that this laboratory will, when established, rank as one of the most complete of its kind in America. In connexion with this Explosives Laboratory, plans have also been prepared for the erection of two climatic huts. These huts will be of great importance in determining to what extent explosives may be affected by storage. Moreover, having in view the chemical reactions due to the crystallization and exudation that take place in many classes of explosives, it will be possible to demonstrate to what extent deterioration takes place in explosives stored in magazines, when affected by our varied high temperatures in summer, and extremes of cold in winter.

Correspondence, having in view the duplication at Ottawa of the Explosives Testing Station in Great Britain, has for some time been carried on with the Explosives Department of the Home Office. From this it appears that a new Testing Station has recently been erected by the British Government at Rotherham in Yorkshire. Major Cooper-Key, His Majesty's Chief Inspector of Explosives—and to whom the Mines Branch is indebted for many courtesies in connexion with the establishment of the Explosives Division—has undertaken to furnish complete detailed plans of their own Explosives Testing Station. Major Cooper-Key has, however, advised waiting until their new testing plant has been fully tried out, in order that we may have the full benefit of their experience before erecting the necessary apparatus for carrying on the work in Canada. Official information has subsequently been received from Lord Strathcona, Canadian High Commissioner in London, to the effect that details have now been sufficiently worked out by actual tests to warrant the Home Office in forwarding plans and specifications in the near future.

One of the problems in connexion with the establishment of the Explosives Division of the Mines Branch is the appointment of men specially fitted for the work. Applicants for the position of explosives chemist would, of necessity, have to be duly qualified for the chemical and physical examination of explosives, and would be required to possess a wide knowledge of the intricate details of manufacture of same, amplified by a personal knowledge of conditions as they exist in Canada to-day. It is doubtful whether, at the present time, any of our own educational institutions are in a position to furnish the training which the requirements of such a position demand. In his recent report on the explosives industry in Canada, Captain Desborough, H. M. Inspector of Explosives, remarks:—

"The responsibility of the chemical adviser to the department will be considerable, as in his hands will rest the recommendation for acceptance or rejection of explosives. When it is remembered that the authorization of an explosive or otherwise, or the condemnation of a batch of explosives which has been issued from a factory may involve large financial interests, it is hardly necessary for me to point out that this gentleman should be possessed of the highest technical qualifications and integrity. The salary of the chemical advisers of the Home Office is entirely dependent on fees; but it would be far preferable if the chemist of the new department were paid an adequate salary so that his whole time should be at the disposal of the government."

In order, therefore, to accelerate the consideration of this question, I have consulted with Sir Francis Nathan, late Superintendant of the Woolwich Arsenal, with the result that he has kindly submitted the names of several experts whom he considers qualified to fill this position.

It is of supreme importance that special care and discrimination be taken in the selection and appointment of a Chief Inspector; for it is better to have no law at all, than one poorly administered. The duties attached to such a position demand not only a thorough and intimate acquaintance with the technology of explosives, but a conspicuous administrative and executive ability as well; for the Explosives Act, as drafted, gives only general powers, and contains scarcely any detail. Indeed it

has been considered advisable to avoid as far as possible, any hard and fast regulations, since in this way scope is allowed for differences of conditions and material, and, within reasonable limits, for the interpretation of each case on its own particular merits. Under such circumstances, therefore, it is obvious that the successful administration of the Act will depend almost altogether on the ability of the Chief Inspector. Commenting on this appointment, Captain Desborough remarks:—

"I cannot state too emphatically that the chief inspector should have sufficient technical knowledge, not only to enable him to administer what must of necessity be a very technical Act, but also to deserve the confidence of the explosives manufacturers. As men possessing such qualifications are rare, I would venture to suggest that it would be very unwise to attempt to economize by offering an inadequate salary."

In conclusion, it may be mentioned that during the year 1911, four explosions in explosives factories—accompanied in each case by fatal results—have come to the attention of the Mines Branch as follows:—

(1) An explosion on April 27, in the drying house of the Dominion Explosives Company at Sand Point, in the Province of Ontario, whereby, four men lost their lives.

(2) An explosion on September 24, 1911, in a dynamite packing house of the Canadian Explosives Company at Belœil in the Province of Quebec, whereby, one man was killed. We have been informed that, of four others who were at the same time seriously injured, three have subsequently succumbed to their injuries.

(3) An explosion on October 19, 1911, in the mixing house of the Curtis and Harvey Company, of Canada, at Rigaud, in the Province of Quebec, whereby, four men lost their lives.

(4) An explosion on December 19, 1911, in the gelignite mixing house of the Canadian Explosives Company, Limited, at Northfield near Nanaimo, British Columbia; whereby, three men were killed, and three injured.

In the Summary Report of the Explosives Division by Mr. J. G. S. Hudson, will be found detailed reports of the various explosions noted above. These reports—which are based on official personal investigation by Mr. Hudson—substantiate the plea that has already been advanced, as to the necessity for immediate legislation for regulating the manufacture, testing, importation, and storage of explosives in Canada.

DIVISION OF MINERAL RESOURCES AND STATISTICS.

The work of the Division of Mineral Resources and Statistics consists in the collection and compilation, in a form readily available for reference, of statistics of the mining and metallurgical production throughout Canada. This Division also keeps a record of all information directly affecting the country's mineral resources in general. The following statistical returns, bulletins, and reports, have been issued by the Division during 1911:—

No. 102.—Preliminary Report of the Mineral Production of Canada during the calendar year 1910.

No. 88.—Annual Report of the Mineral Production of Canada during the calendar year 1909.

No. 114.—The Production of Cement, Lime, Clay Products, Stone, and other Structural Materials in Canada during the calendar year 1910.

No. 115.—Production of Iron and Steel in Canada during the calendar year 1910.

No. 116.—Production of Coal and Coke in Canada during the calendar year 1910.

No. 117.—General Summary of the Mineral Production in Canada during the calendar year 1910.

During the latter part of the field season, Mr. C. T. Cartwright spent some months in British Columbia, gathering data for the proposed revision of the Report on the Mining and Metallurgical Industries of Canada (1907-8). Mr. Cartwright also secured much valuable information in connexion with the work of the Statistics Division.

The usual annual report of the mineral production during 1910 will be issued as soon as possible; but the preliminary report already published—which is included as an appendix of this report—constitutes a complete synopsis of the mineral production of Canada during 1911.

The total mineral production during 1910 is valued at $102,291,686—as compared with $106,823,623 for the preceding year. The causes which resulted in this decrease are referred to in detail elsewhere in this report.

In his report for 1910, the officer in charge of this Division referred to the desirability of a special investigation concerning the markets in Canada—among manufacturers and others—with particular reference to the numerous mineral products in various stages of refinement. It was then pointed out that, whereas considerable quantities of mineral products which have undergone some process of treatment are being imported, the crude mineral ores themselves are exported. It thus appears that a knowledge of the requirements of the Canadian consumer in this respect might be of great assistance in the development of numerous branches of our mineral industries. Recognizing the value of such an investigation, an officer of the Mines Branch spent several months during the past season in collecting data regarding actual conditions. The results of this work are discussed elsewhere in this report.

THE VALUE OF MAGNETOMETRIC SURVEYING IN EXPLORING FOR NICKELIFEROUS PYRRHOTITE.

During the field season of 1911, a magnetometric survey was made of a small mineralized area situated in the Sudbury nickel field. This work was of a purely experimental character, and was undertaken with a view to determining the value of the magnetometer when applied to the exploration of nickeliferous pyrrhotite deposits.

The area selected for investigation was one regarding which more or less complete data had already been secured by means of diamond drilling. It was thus possible to compare the evidences of mineralization, as indicated by the magnetometer, with the actual conditions as previously determined.

The results of this work indicate that, when the ore bodies are fairly uniform in character and composition, the magnetometer will be of assistance, both in extending the known boundaries of deposits already recognized, and also in determining the existence and general extent of new deposits.

It would thus appear that exploration by means of magnetometric surveys may also be extended to any other ore deposits in which magnetite or pyrrhotite is known to be an accompanying accessory mineral. As an example of this may be cited the copper deposits of Texada island, B.C., where the copper pyrites occurs associated with magnetite.

CHEMICAL LABORATORY.

The summary report of Mr. F. G. Wait, indicates that the work of the Chemical Laboratories has, as heretofore, been confined very largely to the examination and analyses of such minerals, ores, etc., as are deemed likely to prove of economic value and importance. A considerable number of rock analyses have, however, been also made.

Inability to secure adequate accommodation under one roof has, in the past, more or less handicapped the work of this Division. On the completion, however, of the permanent quarters now in course of preparation for the Mines Branch, the present decentralization—which until now, has resulted in the work being carried on in separate buildings in different parts of the city—will be obviated.

It may be added that the work of the Chemistry Division has grown to such an extent as to necessitate the engaging of an additional assistant chemist. Hence, not only will the new laboratory afford improved facilities in the matter of modern equipment, but it will also allow sufficient space for needed additions to the present staff of chemists.

DOMINION OF CANADA ASSAY OFFICE, VANCOUVER, B.C.

In another section of this report, will be found the complete financial statement dealing with the operations of the Dominion of Canada Assay Office for the year ending December 31, 1911. This statement accurately reflects conditions at present affecting our Vancouver office. It will be remembered that this assay office was established during the month of July, 1901. Owing, however, to various causes, its operations have never met with that degree of success which had been confidently anticipated. Certain regulations affecting the rates charged, and which have resulted in discrimination in favour of the United States Mint at San Francisco, must be held largely responsible for the present unfortunate state of affairs.

In the official report for 1910, issued by this Department, attention was directed to the manifest and unfair handicap under which the assay office at Vancouver has been, and still continues to be operated. The following memorandum received from Mr. G. Middleton, Manager of the Vancouver office, conveys a very accurate idea of the general conditions affecting the movement of gold bullion on the Pacific Coast:—

DOMINION OF CANADA ASSAY OFFICE.

VANCOUVER, B.C., November 25, 1911.

SIR,—I beg respectfully to submit the following particulars relative to the utility of the Assay Office, and the desirability of shipping the gold purchased at same to the Mint at Ottawa, instead of selling it to the Assay Office at Seattle or to the Mint at San Francisco.

The Vancouver Assay Office was established during the month of July, 1901, but its operations have been more or less hampered and handicapped during the greater part of its history, the charges imposed during a period dating from July 1, 1902, to June 30, 1906, being nearly double those imposed at Seattle.

The charges were adjusted on July 1, 1906, to meet those imposed at Seattle. But in the meantime it was found that gold bullion could be shipped by registered mail from Dawson to the Mint at San Francisco, where the charges were one-eighth of one per cent less on the gross value of the bullion deposited, than at this office or at Seattle, and the bullion from the Yukon was thereafter largely marketed at San Francisco instead of at Seattle.

The commercial men of Vancouver, realize and freely express the opinion that the Assay Office should be one of this city's most valuable assets, but they have also

time and again expressed the opinion to me that it has been discriminated against. These opinions have sometimes been expressed in a very antagonistic mood, emphasizing the fact that such discrimination has been the means of diverting millions of dollars' worth of trade to a foreign country. The supplies required in connexion with the operation of the mines in the Yukon and British Columbia are, of course, purchased at some point on this coast, and if the output of the mines is marketed in the United States the supplies are naturally purchased there, since hams, bacon, eggs, stoves, shelf hardware, boilers, mining machinery, miners' clothing, such as overalls, boots, etc., fruits, vegetables, canned goods, etc., etc., can be imported at about the same prices (including customs duty) as they can be bought in Vancouver. There is, moreover, a certain amount of sentiment in the matter. A great many of the mine operators, both in the Yukon and British Columbia, are Americans, and unless the conditions for the marketing of their gold in Canada compare favourably with those obtaining in their native country, they naturally prefer to sell their gold and divert their trade to the country from which they hail.

I have observed that in a region where wheat is produced, the citizens establish a central wheat market or exchange at the most convenient point in that region, and that the same remark applies to cotton or wool, or any of these great staple products. But when gold happens to be the commodity, it falls to the Government to establish this market or exchange. If, however, the Government should establish that market at a point several thousand miles from the region where the gold is obtained, or discriminates against the market or exchange which they have established in that region, it would become apparent that neither course would be of much value or benefit to those immediately interested.

The United States Government has recognized the above-mentioned principle, and has established assay offices and mints in the gold producing states, so that the gold can be marketed in the region where it is obtained; and unless the same course is followed in Canada, the greater part of the output of our gold mines will continue to be marketed in a foreign country. The State of Washington is not a gold-producing state, but when gold was discovered in the Yukon Territory the United States Government, recognizing what it meant in trade, established an assay office at Seattle for the purchase of the gold. That city consequently secured the trade that accompanied the marketing of the gold; it being a recognized fact that it was the trade accompanying the marketing of the output of the Yukon gold mines, that built up Seattle. The charges imposed at our Vancouver office are now the same as those in force at the Seattle Assay Office, but the charges at the Ottawa and San Francisco Mints are one-eighth of one per cent less on the gross value of the bullion deposited than at this office. The result is that the Yukon gold output is marketed at the two latter mentioned institutions, the transportation charges on gold bullion from Dawson to Ottawa and San Francisco by registered mail being the same as to Vancouver.

There is still a large amount of bullion from Alaska deposited at the Seattle Assay Office, the Nome and Fairbanks trade being mostly in the hands of large trading and banking concerns which have their headquarters in Seattle. These companies consequently market the gold, which they have gathered in trade, at the Seattle Assay Office, and the small mining operators in the region where these big concerns operate naturally follow the lead of the big commercial concerns. This makes the volume of business transacted by the Seattle office, including the bullion received from this office, sufficient to warrant their operations being published regularly.

By adjusting the charges so that they would be the same as those imposed at the Ottawa and San Francisco Mints, this office, in my opinion, could be made a most valuable asset and an institution of which the citizens would be justly proud. Moreover, the benefit accruing in the way of trade and financial prestige, would far outweigh any expense incurred. This office brings considerable trade to Vancouver with its present limited operations, but gold shipped direct to the Mint at Ottawa from

the Yukon or British Columbia might as well be shipped to Philadelphia or to the Royal Mint in London, as the trade and financial prestige that should accompany the primary marketing of the gold, would be scattered instead of being centred in the region where the gold is obtained. All gold, however, purchased by this office should, in my opinion, be shipped to the Mint at Ottawa, as it might be considered as an evidence of weakness to be marketing the output of our gold mines in a foreign country, instead of refining and minting it in Canada and thereby realizing a handsome profit in seigniorage on the silver contained in the bullion. This office has been paying 47 cents per standard ounce for silver during the whole of this season, and if we purchased bullion in the course of a season to the value of $5,000,000, there would be a gross profit of $45,385 in seigniorage on the silver contained in same, that is, provided the Government refined and coined the bullion.

Five million dollars value of bullion, at $16 per ounce, would represent 312,500 ounces of bullion; and 18 per cent of the bullion being silver (that being a fair average) would give 62,500 standard ounces of silver. This amount, at 47 cents per standard ounce, would be equivalent to $29,375. Therefore, since a silver dollar piece (United States) contains 0·836 standard ounce silver, it follows that 62,500 standard ounces, which cost $29,375, would make $74,760, leaving a gross profit on the transaction of $45,385. From this sum there would only be the expense of insurance on the bullion in transit, refining, and minting to deduct. In selling the bullion purchased by this office to any of the different institutions in the United States, we merely get what we pay for it, the United States Government making the seigniorage profit on the silver contained in the bullion.

Considering that the banks, or in fact anyone, can ship gold bullion by registered mail from the Yukon Territory and British Columbia to the Ottawa Mint, I presume the same privilege would be extended to this office, the only difference being that it would not be necessary for this office to put postage stamps on the parcels of bullion. Instead, such parcels would be mailed "O.H.M.S.," insured, the rate of insurance being 35 cents per thousand dollars value on gold bullion by registered mail Vancouver to Ottawa.

Looking at the whole matter from a constructive and a progressive standpoint, and with the view of strengthening our institutions, there would appear to be only one course to pursue, viz., that the primary market for the gold obtained in the Yukon Territory and British Columbia, should be at the most convenient point in the region where the gold is obtained. As it was decided many years ago that Vancouver should be that point, and an Assay Office established there accordingly, it only remains to adjust the charges imposed at that office, so that it will serve the purpose for which it was established.

I am, Sir,

Your obedient servant,

(Signed) **G. Middleton,**

Manager.

As intimated by Mr. Middleton, the commercial men of Vancouver have time and again protested on the ground that this discrimination in assay rates has, by favouring a United States institution, been the means of diverting a very large trade with northern ports to a foreign country. Official utterance is given this sentiment in a recent communication from the Board of Trade of the city of Vancouver:—

Vancouver Board of Trade,

Vancouver, B.C., November 17, 1911.

The Honourable the Minister of Mines,

Ottawa.

Sir,—By instruction of the President, I have the honour to advise you that the Board is informed that the charges on gold assayed at our local Assay Office

being one-eight of one per cent higher than the charges made in San Francisco and also in Ottawa, the result is, that less than one-fourth of the gold produced in the Canadian Yukon comes to Vancouver and by much the heaviest consignments from Dawson go to San Francisco.

This cannot but be detrimental to our local business interests as the rule always has proved itself true, that trade follows the gold.

In the interests of our city, this Board would, therefore, respectfully request that you may be pleased to look into the matter and, if our information be correct, may so direct that the Vancouver Assay Office be placed on an equality with the other offices named.

I have the honour to be, Sir,

Your obedient servant,

(Signed) **W. Skene,**

Secretary.

In conclusion, I would again call attention to my own memorandum of December 5, 1911, dealing with the above question:—

Memorandum:

OTTAWA, December 5, 1911.

Honourable W. B. NANTEL, M.P.,
Minister of Mines.

In further reference to the letter from the Secretary of the Vancouver Board of Trade relating to the charges made on deposits at the Dominion of Canada Assay Office, Vancouver, B.C., I have the honour to enclose a copy of a memorandum on this subject, submitted to me at my request, by the Manager of the Assay Office. This memorandum deals also with the utility of the Assay Office and the desirability of shipping the gold purchased at same to the Mint at Ottawa instead of selling it, as has been our practice, to the Assay Office at Seattle, or to the United States Mint at San Francisco.

In view of the facts presented by the Manager, and those ascertained by myself and reported upon in my Summary Report for 1910, page 20, I strongly recommend that, as regards charges, the Assay Office at Vancouver be placed in the same position for the purchase of gold as the United States Mints and the Mint at Ottawa, by abolishing the charge of one-eighth of one per cent on the gross value of the deposit. This charge was adopted to defray, in part, the expenses and maintenance of the Assay Office.

I further recommend that gold hereafter purchased at our Assay Office, Vancouver, B.C., be sent to our own Mint at Ottawa, and that advantage be taken of the present system of shipping the gold from Vancouver to Ottawa by registered mail.

The charges at present exacted were authorized by Order-in-Council, dated May 10, 1906, and are as follows:—

"The charges to be made on each deposit after assays to be as follows:—

On gold on which royalty has been paid:—

1st charge: Assaying and stamping charge: $\frac{1}{8}$ of 1 per cent on the gross value of the gold and silver contained in the deposit.

2nd charge: Parting and refining charge: 4 cents per ounce of the weight after melt.

3rd charge: Toughening and alloy charge: 2 cents per ounce on $\frac{1}{11}$ of the standard weight of gold contained in the deposit.

a. In paying for silver,* $\frac{1}{99}$ of the standard weight of the gold to be deducted from the gross standard weight of the silver contained in the deposit. (This deduction is to cover loss in converting silver from solution.)

b. On gold on which no royalty has been paid an additional charge of one dollar on each melt is to be exacted."

The recommendation of discontinuing one of the charges, relates to the first charge. The other charges are Mint charges to defray expenses incurred at the Mint in preparing the crude gold for coinage and alloying with copper.

In provision "b", a concession is made to depositors who have paid a royalty on their gold to the Department of the Interior on Yukon gold, by omitting the charge of one dollar on each melt.

Respectfully submitted,

(Signed) **Eugene Haanel,**
Director of Mines.

INVESTIGATION OF THE CANADIAN MARKET FOR VARIOUS MINERAL PRODUCTS IN A CRUDE OR PARTIALLY-PREPARED STATE.

Mr. Fréchette was engaged during the field season, in collecting data from manufacturers in the Provinces of Ontario and Quebec, concerning the minerals used by them with special regard to the quantity, quality, and present source of supply. The ultimate object of this investigation is, to still further encourage the use of Canadian minerals; to point out to the producers the requirements of the domestic market; and to indicate the form in which the minerals should be prepared for use in the various industries in which they are to be employed.

In the course of this inquiry, Mr. H. Bradley acted as assistant to Mr. Fréchette. During the season, sixty-nine towns and cities were visited in the Province of Ontario, and twenty-five in the Province of Quebec.

BITUMINOUS SHALES OF NEW BRUNSWICK.

It is to be regretted that, as yet, active development of the bituminous shales of the Province of New Brunswick, has not been commenced. Although the existence, and to a certain extent, the value of these deposits, have been recognized for many years, all attempts to establish a mineral oil industry have, in the past, ended in failure. This failure may be considered as having been due, in part, to an imperfect knowledge of the chemistry of the shales themselves, and partly to an attempt to utilize machinery which was quite unsuited for the purpose to which it was applied. Finally, the discovery of the Pennsylvania oil wells, in the early sixties, ended what had always been a struggling industry.

In 1908, therefore, a thorough and systematic investigation into the economic possibilities of these shales was initiated by the Mines Branch. As a result, not only were the shale deposits in New Brunswick carefully examined, but a Commission was dispatched to Scotland—the recognized home of the oil-shale industry. This Commission made a comprehensive study of the Scotch deposits, correlating them with the Canadian shales, and reported fully on the economic aspect, and technology of the oil-shale industry.[1] On practically every point this report was favourable to Canadian shales. Particularly favourable conditions appeared to control the manufacture and marketing of the products of such an industry. The conclusions, based on the investigation of this Commission, were eminently satisfactory.

This report has now been in the hands of the mining public for upwards of two years; but unfortunately up to the present time, conditions quite apart from economic considerations—and not related in any way to the real value of the shales themselves—have retarded actual development in the New Brunswick areas. It is

* Bituminous or oil-shales of New Brunswick and Nova Scotia, by R. W. Ells, LL.D., F.R.S.C., Mines Branch, Department of Mines, Ottawa, 1910. (No. 55).

reported, however, that the control of the greater part of these shale deposits has recently passed into the hands of strong and responsible financial interests, and it is confidently anticipated that the work of development will shortly be commenced on an extensive scale.

As the source of an ideal producer of heat, light, and power, the value of these deposits of oil-shale is very great. This is especially true when we consider the rapidly growing demands for liquid fuel as applied to marine transportation. Moreover, in its chief by-product, sulphate of ammonia, it has an even more important and a wider application among the agricultural interests of this country and, recently, attention has been directed to the economic utilization of the "spent shale" from the retorts, *i.e.*, the shale from which the valuable volatile constituents have been already distilled.

Situated more or less conveniently with regard to the beds of oil-shale, are deposits of gypsum, limestone, and clays of various kinds. Thus the possibility of utilizing the "spent shale" in combination with the gypsum and lime for the manufacture of Portland cement, at once suggested itself. Consequently, samples of these various materials were submitted by the Mines Branch to a cement expert, Mr. Richard K. Meade, of Pittsburgh, Penn. Results of Mr. Meade's analyses and determinations are given herewith. It is to be regretted that localities from which certain of the samples were taken are not more specifically indicated.

"The materials investigated consisted of the following samples:—

Limestone—Marked "No. 2 joining Albert Mines on the south side."
Limestone—Marked "No. 3 N.E. of Albert Mines prop."
Limestone—Marked "McHenrys."
Limestone—Unmarked.
Oil-bearing shale—Albert Mines property.
Clay— " "
Gypsum—Quarries of Albert Mfg. Co., Hillsborough.

Analyses.

All of the above materials were first subjected to a careful chemical analysis the results of which follow:—

	Per Cent.
(1) *Limestone*—No. 2, joining Albert Mines on south side.	
Silica	12·08
Iron oxide and alumina	3·52
Carbonate of lime	81·60
Carbonate of magnesia	2·29
(2) *Limestone*—N.E. of Albert Mines prop. No. 3.	
Silica	7·42
Iron oxide and alumina	2·82
Carbonate of lime	88·15
Carbonate of magnesia	1·36
(3) *Limestone*—McHenry.	
Silica	1·04
Iron oxide and alumina	0·64
Carbonate of lime	98·43
Carbonate of magnesia	0·26
(4) *Limestone*—Unmarked sample.	
Silica	18·82
Iron oxide and alumina	6·42
Carbonate of lime	71·07
Carbonate of magnesia	2·53
(5) *Oil-bearing shale.*	
Silica	30·31
Iron oxide	4·46
Alumina	11·52
Lime	6·06
Magnesia	3·48
Volatile matter (oil, etc.)	38·38

(6) *Clay.*

	Per Cent.
Silica	75·44
Iron oxide	3·45
Alumina	11·41
Lime	0·89
Magnesia	1·05

(7) *Gypsum.*

Silica	0·34
Iron oxide and alumina	0·16
Lime	32·27
Magnesia	0·07
Sulphur trioxide	46·69
Loss on ignition	20·80

"These analyses indicate that satisfactory Portland cement can be made from a combination of any one of the first three limestones, and the residue from the oil-bearing shale. The fourth sample of limestone does not contain enough carbonate of lime to be used with the residue from the oil-bearing shale; but it could be employed with either of the first three limestones to make Portland cement. For instance, a mixture of 100 parts of this limestone, and 17 parts of the No. 3 (McHenry's) limestone, would make excellent Portland cement. The clay is too high in silica and too low in alumina to be employed satisfactorily for the manufacture of Portland cement. The gypsum is very pure, and is very suitable for use as a retarder of the setting time of Portland cement.

"As I understand that the purpose of this investigation is to determine the suitability of the residue from the oil-bearing shale for Portland cement manufacture, and as the quantity of limestone No. 2 was greater than that of any of the other limestone samples, I made a trial lot of cement from these two materials and applied the usual tests to this cement. Details of this experiment follow.

Experimental Manufacture of Cement.

"The shale was first crushed roughly and ignited at a red heat until all the oil was expelled. It would be chemically possible to make cement from the oil-shale as it is mixed, but it would be very hard to grind the shale and limestone mixture if the former contained the oil. It would, of course, also be more advantageous from economic reasons also to first distill off the oil owing to the value of the latter. The residue from the oil-shale had the following composition:—

Analysis of the Oil Shale Residue.

	Per Cent.
Silica	49·58
Iron oxide	7·30
Alumina	18·84
Lime	9·91
Magnesia	5·69

"The shale oil residue and the No. 2 limestone were mixed in the following proportions:—

Limestone, 100 parts by weight.
Shale oil residue, 16½ parts by weight.

"The mixture of the two was next ground until 95 per cent of it passed through a test sieve having 100 openings to the linear inch (a No. 100 cement test sieve). The chemical composition of the pulverized mixture was then checked and found to agree with the following calculated figures:—

Analysis of the Pulverized Mixture.

Silica	13·38
Iron oxide	1·82
Alumina	4·29
Lime	43·80
Magnesia	1·38

"The chemical composition of the mix having been proved to be satisfactory the mixture was burned in a small experimental kiln, which was kept at the same temperature as is employed in industrial rotary kilns of 2500° to 2700° F. After cooling, the resulting clinker was mixed with 2 per cent of the gypsum, and ground to the same degree of fineness as is employed in commercial work. The analysis and tests of the resulting experimental cement follow:—

Analysis and Tests of Experimental Cement.

ANALYSIS.

Silica	21·36
Iron oxide	3·05
Alumina	7·01
Lime	63·56
Magnesia	2·05
Sulphur trioxide	1·12
Loss on ignition	1·18

TESTS.

Fineness (Standard cement test sieves)—

Passing No. 100 test sieve	95·1
" " 200 "	81·6

Setting time (Gilmore's needles)—
Initial set, 2 hours and 15 minutes.
Final set, 5 hours and 45 minutes.

Soundness (Thin edge pats)—
Boiling test, 5 hours, perfect.
Steam test, 5 hours, perfect.
Air pat, 28 days, perfect.
Cold water pat, 28 days, perfect.
Specific gravity—3·21.
Tensile strength.

Time in air	1 day	1 day	1 day	1 day	1 day
Time in water	O	6 days	6 days	27 days	27 days
Total age	1 day	7 days	7 days	28 days	28 days
Composition	neat	neat	1 : 3 sand	neat	1 : 3 sand
Pounds per	330	650	245	815	315
square inch	315	670	260	825	335
Average	313	660	253	820	325

CONCLUSIONS.

"The above tests show that a high grade Portland cement can be made from the oil-shale by mixing with the same, limestone of the character of the samples which I received marked (1) 'No. 2 Joining Albert Mines on south side.' (2) N.E. of Albert Mines property No. 3, and (3) 'McHenrys.'"

INVESTIGATION OF METALLURGICAL PROBLEMS OF ECONOMIC IMPORTANCE.

It is generally conceded that the phase of Mines Branch operations which may be described as *original research work*, constitutes one of the most important features of departmental activity. As a recent illustration of the great practical value of such research work, in general, may be cited the success that has recently attended the electro-thermic production of pig iron in Sweden. As a result of this success—which is only one of the many instances which might be mentioned—it is confidently believed that electric furnaces will entirely supersede the charcoal furnaces of Sweden. To pioneer investigation by the chemist, the metallurgist, and the physicist, may be attributed the very great progress which is, to-day, synonymous with modern industrial development. Thus, such questions as the application of new methods of metallurgical treatment, and the discovery of new uses for our minerals themselves, are clearly of very real importance to the mining industry of the Dominion

An example of the practical results that may be anticipated from such research work, is presented in connexion with the conditions which at present govern the marketing of Cobalt ores. Canada is now, practically, the sole producer of cobalt ore; the cobalt content of the ores mined in the Timiskaming district exceed 2,000,000 pounds per year. The market for this, at present, depends altogether on its limited use as a blue colouring substance. Hence there is a large accumulation of

cobalt oxide at the smelters and at the Cobalt camp. Under present industrial conditions, the smelters refuse to pay for the cobalt and nickel content; consequently, the miner receives nothing for this valuable constituent of the ore. Yet the metal cobalt resembles nickel in almost all its properties. Its density, malleability, ductility, hardness, tensile strength, and electrical properties are, so far as they are known, very similar to those of nickel.

These properties of nickel make it of remarkable industrial value in the composition of a great variety of alloys. Of these may be mentioned the high grade steels, where toughness and hardness are desired: for automobile parts, steel tubes, gun steel, cranks and crank-shafts, boiler plates, tires, connecting rods and axles; the nickel-iron wires such as "Invar" and "Platinite," with low temperature coefficients of electrical resistance and of expansion respectively; and the variety of important nickel alloys with non-corrosive properties, for coins, boat propellers, etc.

It would be surprising if cobalt could not be advantageously substituted for nickel to produce a better grade of some of the above products. As these are high grade products, where superior qualities are desired, a high cost, within certain limits, would not be prohibitive. Hence, if research leads to the substitution of cobalt for nickel, even in the case of one of these products, a market for the metal cobalt at a reasonable price would be assured, and large sums of money would be annually added to the returns from Canadian natural resources. With a fair market for cobalt, certain silver-cobalt ores, too lean in silver to be worked at present, might be profitably smelted. The indirect value of an increased market for cobalt is incalculable.

Again, there are, of course, an endless number of possibilities of discovering cobalt-containing alloys, not analogous to nickel-containing alloys, but with valuable commercial properties.

As already noted, cobalt is essentially a Canadian product, hence it is not surprising that foreign investigators have not interested themselves particularly in this field. Up to the present time, very little original work for the purpose of discovering new industrial applications for such ore, has been done. And, realizing that anything which adds to our knowledge of the properties of cobalt and its alloys will be of ultimate value in the development of the industrial resources of the Dominion, and concentrating special attention on alloys which have the promise of immediate commercial use, the value of a comprehensive experimental investigation of the kind indicated, becomes obvious.

Having in view, therefore, practical considerations of far reaching importance such as the above, the Mines Branch recently took steps to further extend the scope of its technical activity. The present crowded condition of our existing laboratories, however, and the impossibility of arranging for suitable accommodation for carrying on research work at Ottawa led the Department to look elsewhere for temporary quarters. Consequently, early in 1910, an arrangement was entered into with the Board of Governors of the School of Mining at Kingston, the general terms of which were as follows:—

(1) That the School of Mining undertake to carry on for the Mines Branch, metallurgical investigations of a directly economic character, and such as may commend themselves to the Director of Mines and the Minister.

(2) That the School of Mining undertake to secure for such work a competent man having as high qualifications as the salary offered will command, and that this officer shall devote his time exclusively to the work of investigation, and shall not be called on to do any teaching in the School of Mining.

(3) That all expenses of the investigations, including salaries, materials, a fair allowance for use of laboratories, and cost of special apparatus required, are to be paid for by the Department of Mines.

(4) That the results of such investigations are to be promptly reported to the Mines Branch, and are not to be used or published otherwise without the permission of the Director of Mines. The consideration of mutual advantage implies that, in the publication of such reports, the fact is made plain that the work was done at the School of Mining, and that it was done for the Mines Branch.

(5) That the metallurgist appointed, report on the metallurgical processes practiced in Canada; render himself conversant with all new developments in metallurgical methods on this continent and abroad; report upon the same; and recommend for special investigation such of these processes as would tend to a more economical treatment of our ores. For this purpose it will be necessary that part of the appropriation for this Research Laboratory be expended in subscribing for all important metallurgical journals; that an annual résumé of all new developments in metallurgy be prepared by the metallurgist, with his criticism and recommendations, for publication in the Summary Report of the Mines Branch.

Various delays have, up to the present, intervened, and have prevented the actual commencement of the above work for upwards of two years. Arrangements recently completed, however, have proved entirely satisfactory, and experimental work is to commence in April, 1912.

Dr. Herbert T. Kalmus, formerly Professor and Research Associate at the Massachusetts Institute of Technology, Boston, and recently Professor at the School of Mining, Kingston, has been appointed to engage in these investigations, and to be Director of the Research Laboratories at the School of Mining for the Mines Branch.

The following programme has been drawn up, and includes investigations which should prove of value to the mining industries of Canada. Dr. Kalmus and his assistants have commenced work on the investigations under captions I, II, and IV, while it is expected to start the investigation under caption III as soon as I is well in hand.

CHARACTER OF INVESTIGATIONS SPECIFIED.

I. An Experimental Investigation of the Metal Cobalt and its Alloys.

II. A Study and Report on the Present Status of the Cobalt Industry.

III. An Investigation of Nickel-Copper-Iron Alloys.

This experimental investigation is to be conducted along similar lines, and with much the same equipment, as the investigation on cobalt alloys. Certain American investigators have claimed that nickel and copper together, in the proportion in which these elements are found in the Sudbury ores, give valuable properties to steel. This subject should be investigated; for if this affirmation be found correct, it might lead to the production of high grade steel, cheaply and directly from Canadian ores, thus using the iron content as well as the nickel and copper.

IV. A Report on the More Recent Advances in the Application of Electro-thermic Processes to the Smelting of Iron Ores and the Making of Steel.

The last named investigation (IV) is educational, economic, and statistical, rather than experimental; and is for the purpose of bringing the various reports of the Mines Branch—which have treated of this subject exhaustively in the past—up-to-date. The pioneer work done by the Mines Branch in connexion with the application of the electro-thermic process to iron and steel manufacture, and the commercial applicability of this method to Canadian conditions, have already been carefully set forth in the publications of the Mines Branch.

During the past two years—as pointed out elsewhere in the present report—electric furnaces have been in active operation at numerous iron and steel plants on the continent, and in the United States, of which much added information and new data have been obtained. Almost every number of the leading electro-chemical or

metallurgical journals contains contributions bearing on this work. The results point uniformly to the probability of a remarkable increase in the use of electro-thermic methods in the iron and steel industries in the near future. The purpose of the proposed investigation is, to review these reports, articles, and papers; to summarize and deduce from them such conclusions as may be of educational, industrial, statistical, and economic value, to those who are already engaged, or about to be engaged, in the iron and steel, or allied industries, in Canada.

IRON.

Mr. E. Lindeman continued his investigation of the iron ore deposits occurring in territory tributary to the Central Ontario railway, in the counties of Hastings and Peterborough. During the field season, some seventeen more or less developed mines and prospects were visited, and magnetometric and topographic surveys made of such properties as appeared to warrant detailed examination.

Mining activity in connexion with the development of these deposits, has been carried on intermittently since 1820. Results in the past have, however, with few exceptions, been rather disappointing. This may be attributed in part to the high sulphur content of the ore, and also to the irregular mode of occurrence, typical of the ore bodies themselves. But, while many of the iron deposits in this district are undoubtedly of little or no value, results of the past season's investigation, carried on by means of magnetometric surveys, have shown that there are at least five properties which appear sufficiently promising to warrant further exploration. These properties represent a probable ore-bearing area aggregating approximately seventeen acres.

It is evident, however, that all these ore-bodies distinctly constitute a concentrating proposition. Failure in the past to recognize this feature must, to a considerable extent, be held responsible for previous lack of success.

In addition to the work in Hastings and Peterborough counties, an examination was also made by Mr. Lindeman of certain occurrences of iron ore situated in Renfrew county near Calabogie. Mining operations in this district were begun in 1881, and have subsequently, at irregular intervals, been continued on the various properties. During this period, upwards of 35,000 tons of good quality, non-bessemer ore have been shipped.

For the most part these ores carry over 50 per cent metallic iron, are low in sulphur, and are conveniently situated as regards shipping facilities. On the other hand, however, the ore bodies are extremely irregular in character, and of such limited extent as to preclude all likelihood of their ever becoming iron producers of importance.

COPPER AND PYRITES.

Dr. Alfred W. G. Wilson, during the early part of 1911, was occupied in gathering material for a special report on pyrites and its uses. During the month of January, a number of the larger chemical works in Canada and the United States were visited, for the purpose of studying the various types of roasting furnaces in operation. Inquiries instituted regarding the market requirements of the various chemical industries, together with such trade returns as are embodied in Dr. Wilson's report, indicate in general the commercial and mining conditions under which the pyrites industry is at present conducted in Canada. A review of the production of pyrites during the past five years, establishes the fact that Canadian operators have more than held their market. Compared, however, with many other branches of mining activity in Canada, the rate of increase as indicated by greater tonnage of shipments, has been comparatively small. A consideration of Dr. Wilson's report appears to indicate that, with a more careful study of existing market conditions in

the United States, there still remains room for a very considerable expansion in the export of Canadian pyrites. Exigencies beyond the control of the Department have somewhat delayed the publication of this report, but it is hoped that it will be available for distribution early in 1912.

During July, Dr. Wilson paid a short visit to the works of the General Chemical Company, at Sulphide, Ontario, and to the pyrites mines in that vicinity.

On July 19, Dr. Wilson left for British Columbia in the continuation of his investigation of the copper industry of Canada. The wide scope and many phases of an investigation dealing with questions of the magnitude of those presented by the copper industry, require no comment. The publication of Dr. Wilson's work will render available to the mining profession and to the general public, the latest and most complete information available with respect to the Canadian production of copper.

NICKEL.

Dr. A. P. Coleman was occupied during a greater part of the field season of 1911, in revising the existing geological map of the Sudbury district, and in gathering material for the preparation of a complete monograph on the nickel industry, with special reference to the Sudbury region. Having been engaged during the two previous summers on behalf of the Canadian Copper Company in a geological study of several of their most important working mines, Dr. Coleman had already had ample opportunity to familiarize himself not only with the geology of the district, but also with the various aspects of mining methods and of metallurgical treatment. Moreover, through the courtesy of the Canada Copper Company, Dr. Coleman has been enabled to make use of much of the material obtained while in their employ. Without these additional data, the results of a single season's work must necessarily have been much less complete.

It is now anticipated that the above monograph will be ready for publication early in 1912. The following are the more important topics which will be discussed:—

(1) General account of the topography, means of communication, etc., with a historical sketch of earlier development.

(2) General description of the ores and their relationship to the enclosing rocks, including surface features and methods of prospecting.

(3) Account of the distribution, size, and importance of the various ore-bodies, both marginal and those belonging to offsets.

(4) Description of all mines which have been worked, with reference to methods of mining employed.

(5) Reference to economic minerals of the interior basin.

(6) Other Canadian nickel deposits; reference to nickel ores of the United States, Europe, and New Caledonia.

(7) Mechanical treatment of Sudbury ores, including magnetic separation and hand-picking; also metallurgical treatment of ore in the reduction of matte, including roasting and smelting as well as a description of the recent improvements at Copper Cliff.

(8) Accounts of methods of refining based on study of working plants; also text of various patents relating to the separation of nickel and copper and the refining of nickel.

(9) Statistics of nickel and copper production.

(10) Account of uses of nickel, of monel metal, of German silver, and of nickel in steel.

(11) Account of precious metals, gold, silver, platinum, palladium, etc., associated with nickel ores.

In connexion with the above work, the first part of the summer of 1911 was occupied in visiting the various nickel-producing centres of the old world, with the object of making a comparative study of conditions affecting mining and metallurgical operations. Dr. Coleman, however, reached Sudbury early in July, and completed his work in that district about the first of October.

Considering the great extent of these nickel-copper deposits, together with the high values carried by the ore itself, Dr. Coleman's report, apart from its undoubted value as a work of reference, appears to furnish ample evidence of large and long continued production from the mines of the Sudbury district.

PHOSPHATE AND FELDSPAR.

Mr. Hugh S. de Schmid, during the greater part of the summer of 1911, was engaged in gathering and in compiling data for a monograph on mica. This monograph—which is expected from the press shortly[1]—supersedes and revises to date, the information contained in the bulletin previously issued by the Mines Branch in 1905.

On the completion of the above work, Mr. de Schmid devoted the remainder of the season to a preliminary study of conditions governing the production of phosphate and feldspar in the Provinces of Ontario and Quebec. Regarding the production of phosphate, the conclusions arrived at by the writer establish beyond doubt the fact that, in competition with foreign production, the phosphate properties of Ontario and Quebec cannot, for the present at least, hope to successfully compete. This conclusion is based not only on a consideration of the general mode of occurrence, but on the general mining conditions governing the working and development of Canadian deposits.

Regarding the production of feldspar, it is shown that practically the whole output—which represents not only the production of Ontario and Quebec, but that of the whole Dominion—is at present derived from the Province of Ontario. This production, while not large, about holds its own from year to year in competition with the larger deposits of the lower grade spar of the United States.

With the above report also appear tabulated statements indicating the relative importance of the phosphate and feldspar industries in Canada and in the United States.

BUILDING STONES.

Professor W. A. Parks, of the University of Toronto, has, during the season of 1911, continued his examination of the building and ornamental stones of Canada. During the summer of 1910, Dr. Parks confined his attention to stones of the Province of Ontario, and the published report of this work is expected from the press shortly. During the present field season this detailed examination was extended to the Maritime Provinces, and to a part of the Province of Quebec. The results of this work will furnish not only descriptions of the different varieties of stone produced in the various localities, but also references to transportation facilities and other conditions affecting production. There is, in the Provinces of New Brunswick and Nova Scotia, a very considerable number of quarries, which were at one time large shippers, but which, owing to various causes, are at present lying idle. Professor Parks has, therefore, given special attention to a study of those circumstances which have adversely affected the stone-working industry.

After completing the work in Nova Scotia, New Brunswick, and Prince Edward Island, Dr. Parks' investigation was further extended to that part of the Province of Quebec lying to the north of the St. Lawrence river.

During the progress of the field work, numerous samples of stone, typifying the production of each locality, were collected. These samples are now being subjected

[1] Published July 10, 1912.

to the various tests for determining the physical and chemical properties, in order to accurately ascertain the particular uses to which each variety of stone may be most economically applied.

It is the intention of this Department to include in the present investigation all the provinces of the Dominion, the data so gathered to constitute a monograph on the building and ornamental stones of Canada. It is, moreover, anticipated that this work will prove of special value to builders, contractors, and others by indicating those localities in which each particular variety of stone may be most readily obtained.

GYPSUM AND SALT.

Mr. L. H. Cole spent the field season in a study of the principal deposits of gypsum and salt in Ontario and in western Canada. Apart from a careful investigation of the mode of occurrence and probable extent of the gypsum beds, Mr. Cole also gathered information concerning mining and milling operations at present being carried on in connexion with the gypsum industry.

The production of gypsum in Ontario is, at the present time, derived chiefly from the well-known deposits occurring along the Grand river, between Cayuga and Paris; while the extensive beds situated near Lake St. Martin constitute the main source of supply in the Province of Manitoba. During the present year, British Columbia appeared for the first time as a producer of gypsum, deposits in that Province occurring at Spatsum, at Merritt, near Grande Prairie, and also on Granite creek near Tulameen. Little actual development has, up to the present, been done on any of these gypsum properties. Considering, however, the satisfactory quality of much of the gypsum, the apparently large tonnage available, and the large and increasing demand for this mineral and its derivatives, there is reason to anticipate in the near future, a considerable development in connexion with the gypsum deposits of British Columbia.

The salt beds occurring in the counties of Essex, Lambton, Huron, and Bruce, at present constitute the salt-producing area in Canada. Besides references to the various localities which were visited in this area, the writer also briefly describes the chief evaporating processes adopted by the different companies operating in this field.

The above report, which includes numerous analyses of samples from different localities, furnishes a general review of the gypsum and salt industries of middle and western Canada.

In conclusion, trade statistics are cited to establish the fact that an excellent opportunity exists for the development of a soda industry in connexion with the evaporation of brine from the wells.

OIL AND GAS DEVELOPMENT IN ALBERT AND WESTMORLAND COUNTIES, NEW BRUNSWICK.

During the year 1908, Maritime Oilfields, Limited, of London, England, acquired control of certain oil and gas leases formerly held by the New Brunswick Petroleum Company, Limited. Under this new control a comprehensive programme was at once inaugurated, and the work of boring for gas and oil in Albert and Westmorland counties energetically prosecuted. The gratifying results which, up to the present time have attended drilling operations, especially in Albert county, should prove an important factor in the industrial development of those parts of Nova Scotia and New Brunswick within reach of the producing wells. The following information relative to the operations of the Maritime Oilfields, Limited, has been furnished this Department by Mr. O. P. Boggs, General Manager of the operating company.

Summary of the producing wells[1] drilled by Maritime Oilfields, Limited, in Albert and Westmorland Counties, New Brunswick.

Well No.	Elevation above sea.	Thickness, oil sands.	Thickness, gas sands.	Total depth.	Yield of Oil and Gas.
	ft.	ft.	ft.	ft.	
3	275	91	33	1,728	Oil about 2 bls. per day. Gas 1,057,338 cub. ft. per day at rock pressure of 95-98 lbs.
5	265	38	83	1,414	Oil about 2 bls. per day. Gas 1,657,593 cub. ft. per day. Rock pressure 110-135 lbs.
7	463	232	12	1,990	Oil about 8 bls. per day. Gas 852,411 cub. ft. per day. Pressure 110-150 lbs.
8	453	83	68	1,680	Oil—variable. Gas 1,738,583 cub. ft. per day. Rock pressure 200-245 lbs.
9	310	63	38	2,060	Oil about 8 bls. per day. Gas 20,000 cub. ft. per day. Rock pressure 30 lbs.
10	456	138	46	1,885	Oil about 5 bls. per day. Gas 907,073 cub. ft. per day. Pressure, 150 lbs.
12	464	43	52	1,955	Oil sands not torpedoed. Gas 3,695,074 cub. ft. of gas per day. Rock pressure 505 lbs.
13	446	116	19	1,628	Oil sands not torpedoed. Gas 1,376,698 cub. ft. of gas per day. Rock pressure 172-200 lbs.
14	424	5	86	1,480	Oil sands not torpedoed. Gas 12,088,848 cub. ft. per day. Pressure 365-379 lbs.
15	395	....	214	1,440	Gas 6,531,840 cub. ft. per day. Pressure 225-230 lbs.
16	405	72	29	1,475	Oil sands not torpedoed. Gas 9,490,049 cub ft. per day. Rock pressure 375 lbs.
17	360	42	28	1,940	Oil sands not torpedoed. Gas 80,000 cub. ft. per day.
18	375	96	1,290 show of gas.	2,175	Only one group of sands could be torpedoed. Yield of oil about 2 bls. per day.
19	290	15	83	1,315	Gas 4,550,764 cub. ft. per day. Rock pressure 370-373 lbs.
20	450	65	133	1,795	Oil sands not torpedoed. Gas 10,295,599 cub. ft. Rock pressure 405-430 lbs.
21	420	147	1,325 show of gas.	1,977	Oil sands not yet torpedoed. Test of natural yield gave 8 bls. per day.
22	325	....	59	1,540	Gas 6,417,488 cub. ft. per day. Rock pressure 500 lbs.

The yield of natural gas from the wells as indicated in the above statement, is the capacity as tested immediately after the gas was struck and the well shut in. A certain allowance must, therefore, be made when calculating, from these figures, the actual capacity of the wells when the gas is being steadily drawn from them. A thorough test, recently made by experts from the United States, indicates that nearly 35,000,000 cubic feet of gas per day may be confidently assumed when the wells are being constantly drawn upon.

Gas mains are already laid to the town of Moncton, and the work of installing the necessary connexions in private houses, stores, and industrial plants is now under way. Moreover, and depending on, the further development of gas which is believed to be certain, it is anticipated that gas will be piped to Hillsborough, Sussex, St. John, Dorchester, Sackville, and Amherst.

The control of the Moncton Tramways, Electricity and Gas Company, Limited, which acts as the distributing company for the gas, has been acquired by Mr. T. N. Barnsdall, of Pittsburgh, Pa. Mr. Barnsdall also controls the Dominion Gas Company, operating in Ontario, and is the largest independent gas producer and distributer in the United States. The following is the tariff of charges which the distributing company proposes to adopt:—

[1] Indicated yield of natural gas is the capacity as tested immediately after the gas was struck and the well shut in.

Domestic consumption—40 cts. per 1,000 cub. feet, with a discount of 2 cts. per 1,000 cub. feet.

Gas engines—27 cts. per 1,000 cub. feet, with a discount of 2 cts. per 1,000 cub. feet. If consumption reaches 75,000 cub. feet per day or over, the rate is 20 cts. per 1,000 cub. feet.

Boiler gas—17 cts. per 1,000 cub. feet, with a discount of 2 cts. per 1,000 cub. feet.

During the season of 1912, the Maritime Oilfields, Limited, in further extending their operations, propose to operate four strings of drilling tools in their Albert County areas.

I have the honour to be, Sir,

Your obedient servant,

(Signed) **Eugene Haanel.**

REPORTS

ON

CHEMICAL LABORATORIES, STATISTICAL DIVISION, ASSAY OFFICE. FUEL TESTING STATION, METALLURGICAL LABORATORY, ETC.

CHEMICAL LABORATORIES.

F. G. Wait, M.A.

Chief Chemist.

During the twelve months ending December 31, 1911, 550 specimens have been reported upon.

Both branches of the laboratory have been in operation during the year until late in December, when the Sussex Street section was closed and its fittings removed on account of extensive changes being made in the interior arrangements of the building. When the operations now being carried on are completed, a new and fully equipped laboratory will be provided in which the two sections hitherto separated will be united.

Mr. M. F. Connor, B.Sc., and Mr. H. A. Leverin, Ch.E., assistant chemists, have worked earnestly and steadily throughout the year, and it is mainly to their efforts that the results here tabulated are due.

Continuing the practice of former years, no more than an outline of the work done is given in this summary, the details being reserved for publication at a later period.

For convenience, the materials here dealt with may be classified as follows:—

FUELS—76 samples, comprising peat, lignite, lignitic-coal, coal, anthracitic coal, and semi-anthracite, as follows:—

I. *Peat*—11 samples from the Holland peat bog, situated in the counties of York and Simcoe, Province of Ontario.

II. *Lignite*—15 samples from the undermentioned localities in—

(*a*) Alberta—

i. Section 32, township 6, R. 12, west of 2nd meridian.

ii. Section 22, township 28, R. 20, west of 3rd meridian, sample from the middle and lower parts of an 8′-10″ seam, at the bottom of a 130 ft. shaft.

iii. Section 16, township 51, R. 9, west of 4th meridian—at or near Mannville. Sample from a 5 ft. seam taken at a depth of 17 feet.

iv. From the Castor Coal Co.'s property at Castor, being the S.W. ¼ of section 3, township 38, R. 14, west of 4th.
(*a*) Sample from the "old mine".
(*b*) Sample from face of entry 1—51 feet from outcrop.
(*c*) Sample from outcrop of entry No. 6—seam 6′-1″.

v. Section 28, township 41, R. 17, west of 4th meridian, at or near Meeting creek.

vi. Section (?), township 53, R. 6, west of 5th meridian.

vii. Section 5, township 49, R. 27, west of 5th meridian, Jasper park.
(*a*) Moose creek—seams undefined—4 samples.

viii. Tofield—from a boring (well No. 1) taken from a depth of 200 feet.

(*b*) Saskatchewan—
ix. Section 21, township 7, R. 21, west of 3rd meridian.

III. *Lignitic coal*—5 samples from—
(*a*) Alberta—
i. Section (?), townships 46 and 47, R. 17, west of 5th meridian, taken from a point south of Edson, on the Grand Trunk Pacific railway.

ii. Section 5, township 49, R. 27, west of 5th meridian, Jasper park, Alberta.
(*a*) Moose creek—seams undefined—3 samples.

(*b*) British Columbia—
iii. Davis creek—north fork, in the Groundhog coal basin, Omineca Mining Division. Sample from the upper seam—4·3 feet.

IV. *Coal*—38 samples from—
(*a*) Alberta (30)—from—
i. Just inside "The Gap" in the Livingston range of mountains.
(*a*) North Race Horse hill—seams 1, 2, 3, and 4—4 samples.
(*b*) South Race Horse hill—seams 1, 2, and 3—1 sample.
(*c*) South Race Horse hill—seam 4—1 sample.
(*d*) South Race Horse hill—an undefined seam—1 sample.
(*e*) Dutch creek—an undefined seam—1 sample.
(*f*) Dutch creek—No. 3 seam—1 sample.
(*g*) Livingston river—1 sample.

ii. Jasper park—section 5, township 49, R. 27, west of 5th meridian.
(*h*) Main tunnel of Jasper collieries, taken across a 9 ft. seam —1 sample.
(*i*) Upper seam—21 feet thick at outcrop—1 sample.
(*j*) Drinnan's claim, taken across a 12 ft. seam—1 sample.
(*k*) Moose creek—from undefined seams—8 samples.
(*l*) Moose creek—from McVicar creek—3 samples.
(*m*) Moose creek—taken at a point one-half mile above 6th meridian crossing—1 sample.
(*n*) Moose creek—from 40 feet below conglomerate—1 sample.
(*o*) Brulé lake, Scovill creek, from Bartholemew's claim, taken from the upper seam—1 sample.

iii. From E. Loder's claim, at the head of Kananaskis river—seam 10 feet—1 sample.

iv. Section 13, township 45, R. 21, west of 5th meridian.
Sample No. 1, from a 9 ft. seam.
Sample No. 2, from a 15 ft. seam.

(*b*) British Columbia (8) from—
1. Nanaimo coal-fields—Vancouver island—
(*a*) East Wellington, No. 1 mine—"run of mine"—ultimate analysis.
(*b*) Extension mine—run of Nos. 1, 2, and 3 mines—ultimate analysis.
(*c*) South Wellington mine—"run of mine"—ultimate analysis.
(*d*) Suquash mine—Pacific Coal Company—ultimate analysis.
(*e*) Extension mine, No. 2—sample of "rash" or dirty coal.

2. Vicinity of Hazelton—Omineca Mining Division—
(*f*) Skeena river—at the "big slide"—9 miles above Kispiox mission—from upper seam—1·9 feet thick.
(*g*) Skeena river—1½ miles above Kispiox mission.

3. Groundhog coal basin. Omineca Mining Division—
(*h*) Specimen taken from the top seam of the section.

V. *Anthracitic coal*—7 samples—all from British Columbia—
(*a*) Omineca Mining Division—
1. Groundhog coal basin—
i. Biernes creek, "Pelletier" seam—5·2 feet thick.
ii. Davis creek near its mouth—4·4 ft. seam.
iii. Discovery creek, upper tunnel—6·0 ft. seam. 0·6 ft. "bone" omitted in sampling.
iv. Trail creek—sample taken across a 6·5 ft. seam.

2. Vicinity of Hazelton—
From the "big slide" on Skeena river, some 17 miles north of Hazelton, or 9 miles north of Kispiox mission.
v. Sample across "middle" seam—2·8 feet coal and 0·9 feet of "bone"—the latter omitted in sampling.
vi. Sample across "lower" seam—6·5 feet coal and 3·0 feet bone—the latter omitted.

(*b*) Skeena Mining Division—
vii. Panorama creek—10 miles west of Groundhog coal basin—selected sample.

VI. *Semi-Anthracite*—3 samples, all from Groundhog coal basin, Omineca Mining Division, British Columbia—
i. Abraham creek, sample across seam, coal 5·05 feet—5 feet "bone" omitted.
ii. Biernes creek—"Scott" seam, 5·3 feet—0·2 foot "bone" omitted.
iii. Discovery creek—lower tunnel, sample across seam. Coal, 5·4 feet—0·4 foot "bone" omitted.

IRON ORES—87 samples from:—
(*a*) Nova Scotia—
1. Annapolis county—
Torbrook—hematite—15 samples examined after treatment at ore concentration plant.
2. Antigonish county—
Siderite, from Copper Lake mine, Polson lake.

(b) New Brunswick—

Gloucester county—so called "Bathurst" ore—from Nipisiguit, 21 miles from Bathurst—three analyses—one on "crude" ore, one on product of concentration, one on "tailings."

(c) Quebec—

Magnetite from "Eardley" farm, on the north shore of the Ottawa river, near Aylmer East, in Wright county.

(d) Ontario—

Algoma district—Goulais river—14 samples, after concentration.

Hastings county—

Carlow	township,	lot 17, con.	VI.
Dungannon	"	" 30, "	XIII.
Faraday	"	" 21, "	XI.
Lake	"	" 17, "	XI.—2 samples.
Mayo	"	" 11, "	IX.—Child's mine.
"	"	" 14, "	IX.
"	"	" 13, "	IX.
"	"	" 10, "	IX.—Rankin mine.
"	"	" 4, "	VI.—Bessemer ore, 3 samples.
Tudor	"	" 57, Hastings road, Horton mine.	
"	"	" 19, con.	XII.—St. Charles mine.
"	"	" 18, "	XVIII.—Baker mine.
Wollaston	"	" 17, "	II.—2 samples.
"	"	lots 15 and 16, con.	VIII.—Coe Hill mine.
"	"	lot 17, con.	VIII.—Jenkins' mine, 2 samples.

Renfrew county—

Bagot	township,	lot 16, con.	IX.—"Tommy R." pit.
"	"	" 16, "	IX.—"I. B." pit.
"	"	" 16, "	IX.—Holden pit.
"	"	" 16, "	VIII.
"	"	S.W. ½ lot 16, con.	IX.
"	"	S.W. ½ " 13, "	X.—Martell mine.
"	"	N. ½ " 21, "	VII.—Culhane ore.
Lavant	"	lots 3 and 4, con.	XII.—Wilbur mine.
"	"	Calabogie.	

(e) Saskatchewan—

26 miles N.E. of Herb lake (Wekusko lake), N. lat. 54° 45′, W. long. 99° 45′—magnetite.

50 miles N. of Moosejaw, 6 miles N. of Canadian Pacific railway—clay ironstone.

(f) Alberta—

Near Burmis—2 samples of magnetite.

(g) British Columbia—

Bog iron ore from Demaniel river, Sooke district, southern Vancouver island, collected by Mr. Charles Clapp, of the Geological Survey.

(h) 27 samples without locality being given.

Black (Iron) Sands:—

Collection of samples from the extensive deposits of iron sands lying along the north shore of the lower St. Lawrence, made by Mr. G. C. Mackenzie and submitted by

him to treatment at the ore concentrating plant. Analyses were made not only upon the original "sand" as collected, but also upon material after treatment, in its different degrees of fineness. Some 70 determinations were made upon 27 distinct samples, or separations, from "sand" taken at the mouth of Natashkwan river, Saguenay county, Quebec. The work is being continued during the early part of 1912.

COPPER ORES—8 samples from:—

(*a*) Nova Scotia—
i. Swan creek, Cumberland county.

(*b*) Ontario—
i. Frontenac county.
ii. Sudbury district from near Webbwood—2 samples.

(*c*) British Columbia.
Sandon, Slocan district—4 samples.

LEAD-ZINC ORES—5 samples:—

The lead and zinc content of five ores was ascertained. Their localities of occurrence were:—

(1) Calumet island, Pontiac county, Quebec—one sample of ore and one of concentrates.

(2) Monarch mine, Mount Stephen, B.C.

(3) Black Prince mineral claim, Mount Field, B.C.

(4) An undefined locality in Frontenac county, Ontario.

LIMESTONES AND DOLOMITES—24 samples from:—

(*a*) Ontario—
i. Bruce county—Cook's quarry, Wiarton.
Lot 39, con. II, of township of Eastnor.
ii. Carleton " —Old marble quarry, Fitzroy Harbour.
iii. Frontenac " —Sanford's marble quarry, Barrie township.
Wallace quarry, Kingston.
iv. Grey " —Perkins' quarry, Owen Sound.
v. Hastings " —Black marble from Madoc.
Ontario Marble Co.'s quarry at Bancroft.
vi. Lanark " —McEwan's quarry, Carleton Place.
Coughlin's quarry, Smiths Falls.
North Lanark Marble and Granite.
Company's quarry, Clyde Forks.
vii. Lincoln " —Gibson's quarry—Beamsville.
Queenston Quarry Company's property, Queenston.
viii. Prescott " —Ross quarry, Hawkesbury.
ix. Renfrew " —McGinnis' quarry, Haley station.
Legris' quarry, Calabogie.
Old quarry, Arnprior.
x. Stormont " —Marcotte's quarry, Mille Roches.
xi. Victoria " —Britnell's quarry, Burnt River.
xii. Wellington " —Central Prison quarry, Guelph.
xiii. Wentworth " —Marshall's quarry, Hamilton.

(*b*) Alberta—
From near milepost 88 on the Grand Trunk Pacific railway.

(*c*) British Columbia—
i. Nootka marble quarry.
ii. Departure bay, Nanaimo.

GYPSUM—22 samples from:—

(*a*) Nova Scotia—
"Blue gypsum" from near Windsor, Hants county.

(*b*) Ontario—
i. Haldimand county—
(*a*) From the Crown Gypsum Company's property, 1 mile southeast of York—6 samples.
(*b*) From a shaft on the Hudspeth property, on the south side of the Grand river, one-half mile west of Caledonia.

(*c*) Manitoba—
i. From a point some 17 miles east of Dominion City, Provencher county.
ii. From the Manitoba Gypsum Company's quarry at Gypsumville—2 samples.

(*d*) British Columbia—
i. From a point 10 miles east of Princeton in Yale-Cariboo.
ii. From a band, 5 feet wide, at Spatsum.
iii. From "Bauxite" claim, one-half mile east of Merritt—2 samples.
iv. From different points on claims situated 10 miles east of Grand Prairie —5 samples.
v. From Warren claims, 1½ miles northwest of the preceding—2 samples.

BRICK AND POTTERY CLAYS:—

Thirteen samples were submitted to complete or to partial analysis to ascertain their fitness for the purpose of manufacture of the several clay products. Of these four were from Manitoba and nine from British Columbia. In no case was the precise locality of their occurrence made known.

OIL-SHALES:—

Determinations of the oil content and ammonium sulphate yield were made upon 10 "oil-shales" from Albert county, New Brunswick.

ROCKS AND MINERAL:—

During the year six analyses were reported, as follows:—
i. From the Tulameen district, B.C.—
(*a*) Granite—Collins gulch.
(*b*) Granite—east side of the northeast end of Otter lake.
(*c*) Granodiorite—Siwash creek.
ii. From Ice river, B.C.—
(*d*) Nepheline-syenite.
(*e*) A rock of the essexetic type.
iii. A sample of scapolite from the Craigmont corundum mine—Raglan township, Renfrew county.

The analytical work upon 9 other samples was carried on, but not completed on the date of closing this summary report.

NATURAL WATERS AND BRINES:—

Two natural spring waters and eight samples of brines have been analysed during the year.

Their several sources are given below—

i. Spring on the banks of Cain river, 10 miles from its junction with the Miramichi in Northumberland county, New Brunswick—a qualitative examination only.

ii. Spring on lot 205, Range of Ste. Antoine, Parish of Ste. Elizabeth, Joliette county, Quebec—a quantitative analysis was made of this sample.

iii. Brines from—

(a) Western Canada Flour Mills' well, Goderich, Ont.
(b) American Chemical Company's well, Goderich, Ont.
(c) Stapleton Salt Works, Clinton, Ont.
(d) Ontario People's Salt and Soda Company's well, Kincardine, Ont.
(e) Sparling Company's property, Wingham, Ont.
(f) Western Salt Company's well, Mooretown, Ont.
(g) Dominion Salt Company, Sarnia, Ont.—old well.
(h) Dominion Salt Company, Sarnia, Ont—new well.

ASSAYS FOR PLATINUM, GOLD, AND SILVER:—

One hundred and eighty seven furnace assays have been made upon material taken in different parts of the whole Dominion.

Under the heading of provinces, their distribution is as follows:—

From New Brunswick	2	samples.
" Quebec	5	"
" Ontario	19	"
" Saskatchewan	2	"
" Alberta	3	"
" British Columbia	97	"
" Yukon district	6	"

In addition to the foregoing, there were 53 samples submitted to assay, of which no particulars of locality of occurrence were furnished.

MISCELLANEOUS EXAMINATIONS:—

Under this caption are placed such analyses—mostly partial—or descriptions of samples as do not properly come under any of the preceding divisions, or concerning which little or no information was given. Here are included upwards of fifty rocks and minerals requiring description or determination of species only—eight supposed tin ore samples from Galetta, Ontario; apatite, gypsum, manganiferous bog iron ore, one sample of each; pyrrhotite for determination of the content of nickel or copper, or both—six samples; pig iron and calcareous marl, of each one sample, two furnace slags; a supposed nickeliferous quartzite from Siwash, B.C.; a supposed tin and tungsten-bearing pegmatite from Dalhousie East, Lunenburg county, N.S.; two samples of material which it was thought might be used as glass sand—one from near Dauphin, Man., and the other from the vicinity of Medicine Hat, Alta.; three samples of well-borings from Ouaitchouan Falls, Chicoutimi county, Que., to determine their mineralogical character; nine sandstones which were to be utilized for building purposes for determination of the quantity of sulphur and iron which they contained; and one sample of tar sand from near Calgary, Alta.

REPORT OF THE DIVISION OF MINERAL RESOURCES AND STATISTICS.

John McLeish, Chief of Division.

The work of this Division, comprising the collection of information respecting the mining industry, the preparation of annual reports on mineral production, etc., and defined more specifically under section 6 (*a*) of the "Geology and Mines Act, 1907," has already been described in some detail in previous summary reports.

During the year 1911 the chief work of the staff was, naturally, devoted to the collection of statistics and the preparation of reports on mineral production for the year 1910. These statistics were collected entirely by correspondence, the returns received directly by this Division being supplemented by information furnished by other government departments and by provincial mining bureaus. Mr. C. T. Cartwright spent several months, from September to November, gathering information relative to the mining industry in British Columbia.

An annual record of the mineral production in Canada has been collected since 1886, and the growth of the industry is significantly shown by the statistics published. In 1886, the total value of the production was $10,221,255, or an average of $2.23 per capita, whereas in 1911, the total value of the production was $102,291,686, or an average of $14.20 per capita.

The annual reports published contain as complete information as was available respecting production as well as a record of exports and imports, together with information respecting the occurrence, development, uses of, and markets for mineral products.

The completion of these reports, which require considerable time both in the compilation and in the printing, is usually so long delayed that a practice has been made of issuing short preliminary reports on mineral production, with statistics subject to revision, and these have almost invariably been completed and distributed during the first week in March in each year. Thus the manuscript for the Preliminary Report on the Mineral Production of Canada during the Calendar Year 1910 was sent to press on February 23, and the printed report of 21 pages was received February 27, 1911. Copies were first distributed at the annual convention of the Canadian Mining Institute held at Quebec, March 1, 2, and 3, 1911, at which meeting a short paper on the mineral production of Canada during the year was read, thus placing before the mining fraternity and the public—at the earliest opportunity—information concerning the extent of Canada's mining output. This report was also published as an appendix to the Summary Report of the Mines Branch for 1910.

The completed report for the year 1909 was received from the printers July 19, 1911.

The separate publication of selected parts of the final reports in the form of advance chapters was continued, and in pursuance of this plan the following reports were prepared and sent to press on the dates indicated:—

The Production of Cement, Lime, Clay Products, Stone, and other Structural Materials in Canada, during the calendar year 1910—August 12.

The Production of Iron and Steel in Canada, during the calendar year 1910—August 11.

The Production of Coal and Coke in Canada, during the calendar year 1910—August 21.

A General Summary of the Mineral Production of Canada, during the calendar year 1910—August 24.

These were issued as advance chapters of the complete Report on the Mineral Production of Canada, during the calendar year 1910, and were all received and distributed before the close of the year. The complete report was transmitted to the printers on October 25, 1911.

Much of the time of the staff is taken up in the furnishing of information to correspondents and others respecting the mining industries and mineral resources of the country.

The routine correspondence of the Division during the year comprised about 1,347 letters sent out and received, in addition to which about 4,308 circular communications were sent out and 2,323 received. Six statistical reports prepared by the Division were distributed during the year, comprising about 11,500 copies. In addition to these reports, lists of operators were also printed as follows: (1) List of Manufacturers of Clay Products in Canada; (2) List of Lime Burners in Canada; (3) List of Stone Quarry Operators in Canada. Copies of these lists were sent to each firm or individual interested for purposes of confirmation and correction.

Mr. Cartwright devoted the first part of the year to office work, and contributed largely to the preparation of the annual report, with special reference to the chapters on metalliferous production. From September to November he was engaged in field work in British Columbia collecting information with respect to the metal mining industry in that Province. Mr. Cartwright furnishes the following summary report with respect to his field work:—

"In accordance with instructions received, the writer spent September, October, and most of November, 1911, in British Columbia with a view to obtaining the necessary data for a revision of the Report on the Mining and Metallurgical Industries of Canada, and information for the work of the Statistics Division.

"Southern British Columbia was covered as thoroughly as time permitted, special attention being paid to the silver-lead and the gold ores, any duplication of work with other officers of the Branch being avoided. Practically all the railway and steamer routes of the south were traversed, with, in addition, trips by stage or saddle horse.

"Copies of the schedules of information desired are appended. At the time of the visit the Kootenay and Boundary districts were feeling the effects of the coal strike, on the Crowsnest, yet there was a most noticeable activity in West Kootenay.

"In the Nelson division considerable interest was shown in the reported discovery of metals of the platinum group; in the new locations in the Sheep Creek lead belt; and in the experiments with the "French" zinc process.

"Ainsworth and Silverton camps of the Slocan were active, several properties re-opening under new owners or reaching a shipping stage, whilst Sandon, Bear Lake, and McGuigan would seem to promise a good tonnage in 1912 with the resumption of work on many well-known properties and the completion of the Bear Lake branch of the Canadian Pacific railway.

"As ever, the economical treatment of zinc ores and zinc-lead concentrates was the question of importance to the Kootenays. At present, in addition to the expensive long freight haul, the ores have to stand the United States import duty of one cent per pound on zinc content, the duty of one and a half cents per pound on all lead content, although for this no payment is made by the smelters, and a deduction of more than twenty-five per cent of the silver value.

"The larger smelting companies of the interior showed considerable activity in the acquirement of new properties, the British Columbia Copper Company, and the Consolidated Mining and Smelting Company extending their operations in West Kootenay, the Boundary, and Similkameen, while the Granby Consolidated Mining and Smelting Company took up their bond on the Hidden Creek mine on the coast.

"The Nickel Plate gold mine at Hedley showed the beneficial results of the improvements to its mill, and near Princeton work was progressing on the coal and other properties.

"On the coast the chief features were the large increase in production from the Britannia mines, and, as mentioned, the development of the Hidden Creek mine.

"The writer was fortunately able to attend the meeting at New Denver, B.C., September 13-14, of the Western Branch of the Canadian Mining Institute, and found his work thereby greatly facilitated, not only from information contained in the papers read, but far more from personal contact with so many of the leading mining men of the Province.

"The chief limitations placed on the work were due to the lateness of the season, the small amount of time at the writer's disposal, and to the fact that an unusually large number of mines were changing hands, or the operating companies re-organizing, making much data for the time unobtainable. Everywhere, however, those interviewed showed the greatest courtesy, so much so that it is impossible properly to acknowledge here the kindness shown and aid given by the officials of the Provincial Department of Mines, of the Western Branch of the Canadian Mining Institute, and by so many others."

SCHEDULE OF INFORMATION SOUGHT.

OPERATING COMPANY.

Company's name.
Head office address.
Capital authorized. in shares of. Issued.
Incorporation. Date. Place.
President. Address.
Vice President, 1st. "
" 2nd. "
Treasurer.
Secretary.
General manager.
Fiscal year ends.
Reports published.
Properties owned or leased.

MINE.

Name. Location.
Operator. Head office address.
Owner (if not operator). Head office address.
Mine office. Local manager.
Property: Area. No. of claims.
How held: Crown granted or leasehold.
Type of ore: Metals contained.
Typical or average analysis.
Type of deposit.
Method of working: Tunnel or shaft. Extent of workings. Shaft depth. Stoping methods. Timbering. Filling.
Power equipment: Horse-power used. Pumping, hoisting, heating. Electricity, steam or water power.
Labour: Day or contract work: Average number employed on surface and underground. Rate and wages paid.
Drilling: Hand, stope drills, machine drills. Number and kind. Diamond drilling.
Shipping: Altitude above shipping point. Distance to and nearest shipping point. Means: rawhide, wagon, rail, tramway. Destination of shipments. Transportation and treatment charges. Products shipped—bullion, ore or concentrates. Methods employed in handling ore, such as handpicking, crushing, etc., previous to milling or shipping. Total value of product to date, if known.
Mill. Stamps, and number, if any. Concentration. Cyanide or other process. Capacity. Average number of men employed. General equipment.
Remarks. Any additional cost data, reference to good description in technical journals of property and special mining methods in vogue, etc., which will add to the value of this report will be appreciated.

A Preliminary Report on the Mineral Production during 1911 has already been prepared and published, as usual, as a separate bulletin. While this statistical record shows a slight falling off in the total value of the production as compared with the year 1910, the decrease is to be largely ascribed to special conditions, among which the labour troubles affecting the coal mining industries of the western provinces are most prominent, and the general prospects in the mining industry would appear to be particularly bright for a largely increased production during the next few years. A great deal of prospecting and development work has been undertaken in many camps, and in many cases with promising results. The building of the Grand Trunk Pacific railway and other lines through central British Columbia and northern Ontario, is opening up rich prospecting ground for the miner. Several new coal fields are being opened up in Alberta and British Columbia which will, in a few years, be supplying a large tonnage for the rapidly-growing population of western Canada as well as for export. An important deposit of copper ore is being developed in the Hidden Creek mine, near Goose bay, Observatory inlet, and preparations are being made for the erection of a smelter.

The Yukon district has hitherto been prominent, chiefly on account of its placer gold production, but the coal resources of this district are now becoming well known through the work of Mr. Cairnes, and its metalliferous deposits are already contributing to our production of silver and copper.

In Alberta, coal mining is an industry, the development of which will be measured by the growth in western population, while the same stimulus is also showing its effects in a rapidly growing production of all those products usually classed as structural materials, including cement, stone, clay products, lime, etc.

The utilization of natural gas resources in western Canada has hitherto been confined to the city of Medicine Hat, but the immediate future is to see large developments in this direction. A number of highly productive wells have been drilled at Bow island, 40 miles west of Medicine Hat, and the gas is to be piped 170 miles to Calgary, and also to Lethbridge, McLeod, and other towns and villages in southern Alberta.

Ontario has the greatest variety as well as the largest production of mineral products of any of the provinces. The nickel-copper deposits of the Sudbury district, which now supply a very large percentage of the world's requirements of nickel, are probably the most extensively developed, and (with the exception of iron) contain the largest ore resources of any metalliferous deposits in Canada.

The silver production from the Cobalt district, although still increasing in annual output and supplying about 14 per cent of the world's production, has probably attracted less attention during the past year than have the gold discoveries at Porcupine. The development of this latter district was considerably retarded by the unfortunate fires that swept the country in the month of July, accompanied by tragic loss of life as well as destruction of property. Already two mines have been sufficiently developed in the judgment of their owners to justify the erection of large mills, the opening of one of which was recently made the occasion for an elaborate celebration. Gold mining in Ontario in the past has been fraught with many vicissitudes, and the successful development of this new district may go far to atone for the losses that have been encountered in other parts of the Province.

The development of the iron ore resources of this Province offers considerable opportunity for an increased mineral production. Hitherto the production of iron ore has not been sufficient to meet the requirements of Ontario's iron blast furnaces, but the introduction of concentration methods in connexion with low-grade deposits would appear to promise a larger supply of domestic iron ore in the future.

The development of metallurgical industries in the Province is also worthy of note. Four plants are now in active operation treating the ores of the Cobalt district, and producing refined silver, white arsenic, and cobalt and nickel oxides.

Two small lead smelters are in course of construction at Kingston, and the re-opening of lead mines at Perth Road and elsewhere would appear to indicate a revival in the lead mining industry of the Province.

The already wide variety of minerals found in this Province was increased during the year by the discovery of mercury and tungsten, the former being found in some of the silver-bearing cobalt ores, and the latter in the form of scheelite in some of the gold quartz veins of Porcupine.

In the Province of Quebec marked increase is shown in the production of copper and sulphur ores. The production of asbestos has increased rapidly in recent years, and although this industry has suffered somewhat from over-production, nevertheless the applications and uses of asbestos are steadily increasing from year to year, and there can be no question of the successful operation of the mines themselves on a reasonable basis of capitalization and having due regard to the limitations of the market.

Another interesting development in the Province is the revival of gold mining in the alluvial deposits of Beauce county.

Coal production is the chief mining industry of the Maritime Provinces, and will no doubt long continue to remain so.

The iron and steel industry which is probably second only in importance to coal, has for a number of years been based almost entirely on iron ores imported from Newfoundland.

The gold output of Nova Scotia has unfortunately seriously fallen off. The discovery and development of tungsten deposits appears to promise an early production of this important mineral. The gypsum deposits of the Maritime Provinces are of enormous extent, and the output for many years will no doubt be limited only by the demand and market for this product.

Statistical details of production during 1911 will be found in the preliminary statement reprinted as an appendix to this report.

REPORT COVERING THE OPERATIONS OF THE DOMINION OF CANADA ASSAY OFFICE, VANCOUVER, B.C., DURING THE YEAR ENDING DECEMBER 31, 1911.

There were 442 deposits of gold bullion, requiring 482 melts and 482 assays (quadruplicate check assays being made in each instance), including the assembling and remelting of the individual deposits after purchase into bars weighing about 1,000 troy ounces each, and the assaying of same. The aggregate weight of the deposits before melting was 39,784·70 troy ounces, and after melting 39,069·31 troy ounces, showing a loss in melting of 1·7982 per cent. The loss in weight by assaying was 5·62 troy ounces (base and parted silver), the average fineness of the resulting bullion, viz.: 39,063·69 troy ounces being ·800[2] gold and ·177 silver. The net value of the gold and silver contained in deposits was $647,416.38.

The gold bullion received came from the following sources:—

Source.	Number of deposits.	Before melting.	After melting.	Net Value.
		ozs.	ozs.	$ cts.
Yukon Territory	44	2,073·61	2,021·02	34,994 39
British Columbia	374	32,176·08	31,523·07	525,746 83
Alaska	23	5,533·20	5,523·54	86,645 91
California	1	1·81	1·68	29 25
	442	39,784·70	39,069·31	647,416 38

Weight before melting	39,784·70	troy ounces.
Weight after melting	39,069·31	"
Loss by melting	715·39	"
Loss percentage by melting	1·7982	

Credits and Disbursements for the Purchase of Gold Bullion During the Year Ending December 31, 1911.

Unexpended balance—"Letter of Credit," January 1, 1911		$ 13,785 14
Credits established during year ending December 31, 1911		700,000 00
"Letter of Credit" balance written off at close of fiscal year, March 31, 1911	$ 37,383 74	
Disbursements for purchase of bullion	647,416 38	
Unexpended balance, "Letter of Credit," December 31, 1911	28,985 02	
	$713,785 14	$713,785 14

Disbursements for the Purchase of Gold Bullion and Receipts from Sale of Same During the Year Ending December 31, 1911.

Disbursements for purchase of bullion on hand, January 1, 1911, bars Nos. 399, 400, 411, 413, 414, 417 to 427 inclusive		$ 7,514 60
Disbursements for purchase of bullion during year ending December 31, 1911—Cheques Nos. 428 to 488 inclusive, and 1 to 381 inclusive		647,416 38
Proceeds from sale of bullion during year ending December 31, 1911	$641,750 21	
Value of bullion on hand December 31, 1911, bars Nos. 346, 347, 350 to 381 inclusive	13,591 37	
Difference in favour of this office		410 60
	$655,341 58	$655,341 58

Contingent Account for Year Ending December 31, 1911.

Unexpended balance, January 1, 1911		$ 25 40
Funds provided per official cheques Nos. 1001, 1027, 1108, 3, 58, 214, 358, 470, 577, 661, 722, and 849		1,689 00
Amount remitted Receiver General, per draft No. 222, at close of fiscal year, March 31, 1911	$ 20 25	
Expenditure during year ending December 31, 1911	1,640 77	
Unexpended balance, December 31, 1911	53 38	
	$1,714 40	$1,714 40

Contingent Expenditure During Year Ending December 31, 1911.

Fuel (gas)	$ 290 65
Power	157 30
Express charges on bullion	509 58
Electric vault protection service	300 00
Postage	10 00
Telephones	44 00
Duty, freight, etc., on assayers' and melter's supplies	32 18
Assayers' and melter's supplies (purchased locally)	182 35
Sundries	114 71
	$1,640 77

Proceeds from Residues Sold March, 1911.

Residue sold to United States Assay Office, Seattle, Wash., U.S.A. (bar No. A 5).	$393 75
Thirty-five empty acid bottles sold to B. C. Assay & Chemical Supply Co., Ltd., Vancouver, B.C.	5 25
	$399 00

Residues on Hand, December 31, 1911.

Recovered from sweepings, slags, old furnaces, old crucibles, etc., viz.—28·25 ounces, value	$333 63
Twenty-four empty acid bottles.	

Miscellaneous Receipts.

Draft No. 208, in favour of Deputy Minister of Mines (a payment for melting jewellery sweepings)	$ 3 00
Draft No. 251, in favour of Deputy Minister of Mines (a payment for treating 60 lbs. slag)	27 50
	$30 50

The following shows the business done by the Assay Office since its establishment:—

Year.	Number of deposits.	Weight (troy ounces)	Net value.
			$ cts.
1901-2 (Fiscal)	671	69,925·67	1,153,014 50
1902-3 "	509	36,295·69	568,888 19
1903-4 "	381	24,516·36	385,152 00
1904-5 "	443	29,573·73	462,939 75
1905-6 "	345	21,050·83	337,820 59
1906-7 (nine months)	269	20,695·84	336,675 65
1907-8 (Fiscal)	482	46,540·25	751,693 97
1908 (nine months)	590	90,175·48	1,478,893 74
1909 (calendar)	573	48,478·60	789,267 94
1910 "	490	46,064·31	746,101 92
1911 "	442	39,784·70	647,416 38

(Signed) G. Middleton,
Manager.

January 2, 1912.

G. Middleton, Esq.,
Manager, Dominion of Canada Assay Office,
Vancouver, B.C.

Sir.—I beg to inform you that we had the following assayers' supplies on hand on December 31, 1911, viz:—

Silver nitrate crystals	1 oz.
Calcic chloride	1 lb.
Lead foil (C.P.)	85 lbs.
" granulated (C.P.)	4 lbs.
Zinc, mossy (C.P.)	3 ozs.
Litharge	10 lbs.
Copper wire	¾ spool
Argols	5 lbs.
Flour	8 lbs.
Nitric acid	15 Winchesters.
Sulphuric acid	¾ Winchester.
Hydrochloric acid	1 "
Ammonia	1½ "
Small clay crucibles	8 only
Scorifiers, 4"	4
" 2½"	25
Spare muffles	3
" doors	4
" supports	14
" back stops	16
" plugs	5
Bone ash ..about	10 lbs.
Fireclay "	5 lbs.
Cupels "	4,200
Gold cornets	6·67 ozs.
" proof	7·80 ozs.
Silver	75·72 ozs.

Yours obediently,

(Signed) J. B. Farquhar,
Chief Assayer.

January 2, 1912.

G. Middleton, Esq.,
Manager, Dominion of Canada Assay Office,
Vancouver, B.C.

Sir,—I beg to inform you that we had on hand on December 31, 1911, in the Melting Department, the following supplies, viz:—

3	sets of linings,	with supports	and covers	complete,	for	No. 1	furnace.
3	"	"	"	"	"	No. 2	"
3	"	"	"	"	"	No. 4½	"
3	"	"	"	"	"	No. 7	"

2	Graphite	crucibles,	No. 6.
2	"	"	No. 10.
50	"	"	No. 16.
1	"	"	No. 30.
27	"	"	No. 40.
45	"	"	marked $^{o}_{o}{}^{o}$

3 Crucible covers, No. 14.
1 Graphite stirrer.
1 lb. pot. nitrate.
16 lbs. carb. soda.
18 lbs. borax glass.

Your obedient servant,

(Signed) **D. Robinson,**
Chief Melter.

ACCOUNTANT'S STATEMENT.

The following is a statement of the difference in value of assays between Seattle Assay Office and Dominion of Canada Assay Office, between April 1, 1910, and March 31, 1911:—

Paid for bullion at Dominion of Canada Assay Office, Vancouver	$762,616 26
Received for bars from United States Assay Office, Seattle	763,322 08
Difference in favour of Dominion of Canada Assay Office	$705 82

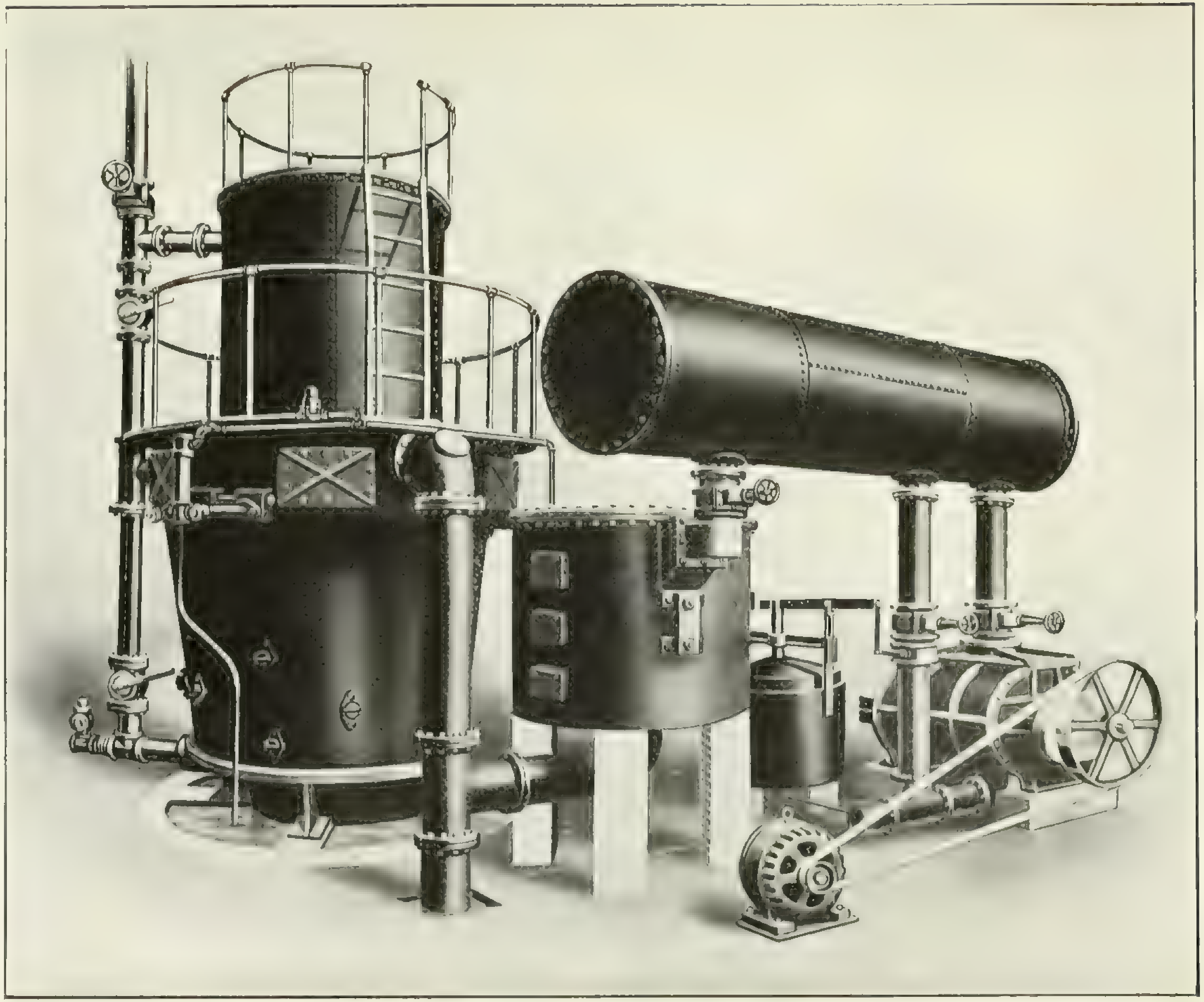
STATEMENT OF DEPOSITS OF GOLD AND EARNINGS.

Deposits of gold		$762,616 26
Earnings:—		
Value of residue sold United States Assay Office	$ 393 75	
" 35 empty acid bottles sold B. C. Assay & Chemical Supply Co	5 25	
Melting 50 ozs. native silver	2 50	
" jewellery sweepings	3 00	
	$404 50	
Difference between amounts paid and received for bullion	705 82	
	1,110 32	

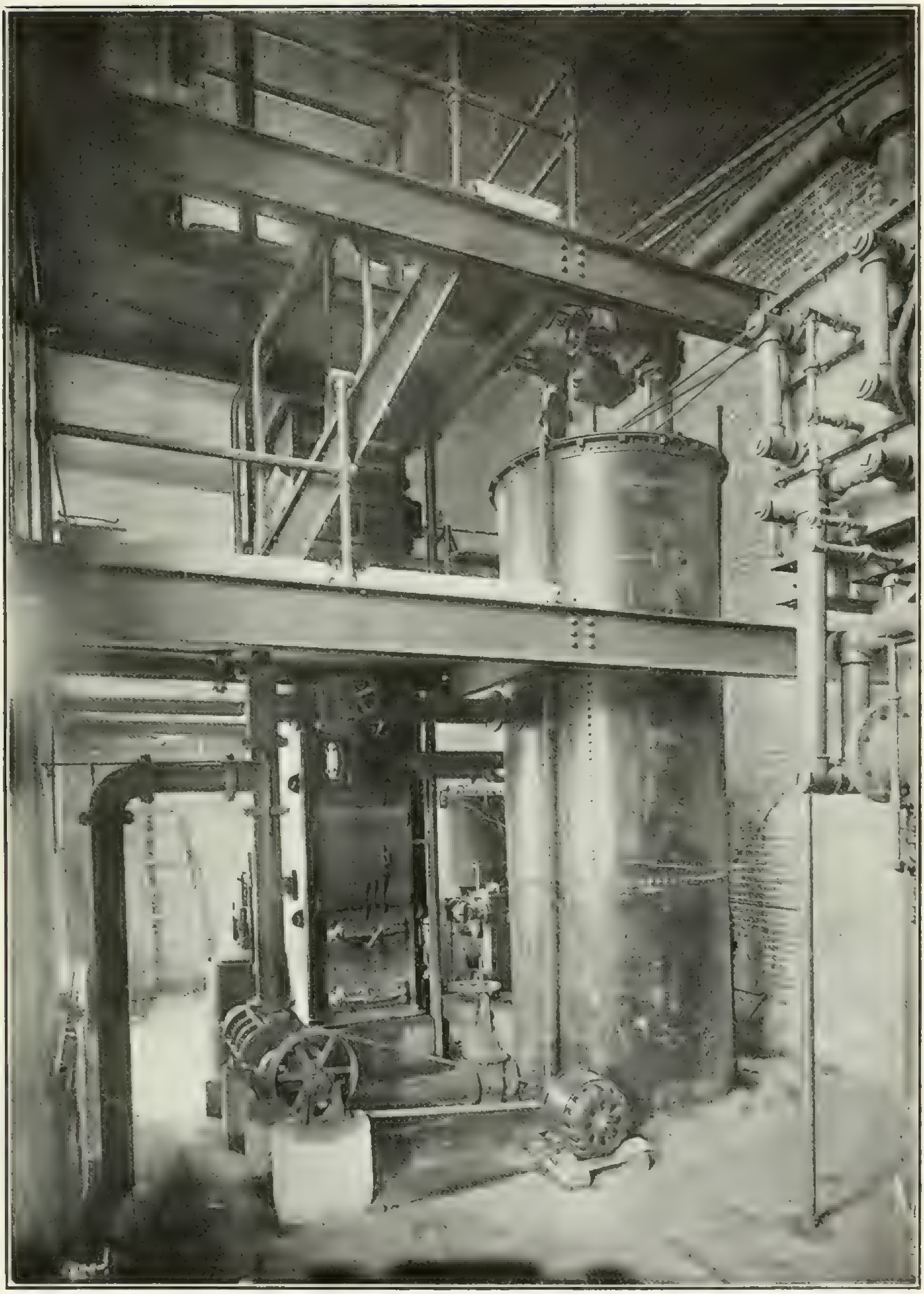
The following is a statement of appropriation, receipts, and expenditure of the Dominion of Canada Assay Office for the year ending March 31, 1911, and shows the unexpended balance to be $4,883.33:—

	Appropriation.	Expenditure
Appropriation, 1910-11	$18,000 00	
Receipts per the foregoing statement	404 50	
Difference between amounts paid and received for bullion	705 82	
Rent		$ 1,500 00
Fuel		283 33
Power and light		159 76
Postage and telegrams		66 43
Telephone		68 50
Express charges		608 49
Assayers' supplies		375 46
Printing and stationery		95 07
Premium on bonds		570 00
Contingencies		98 05
Electric burglar alarm service		506 00
Wages—		
G. Middleton		2,650 00
J. B. Farquhar		1,527 15
D. Robinson		1,575 00
A. Kaye		1,800 00
G. N. Ford		1,368 75
G. B. Palmer		975 00
Balance unexpended		4,883 33
	$19,110 32	$19,110 32

(Signed) Jno. Marshall,
Accountant.

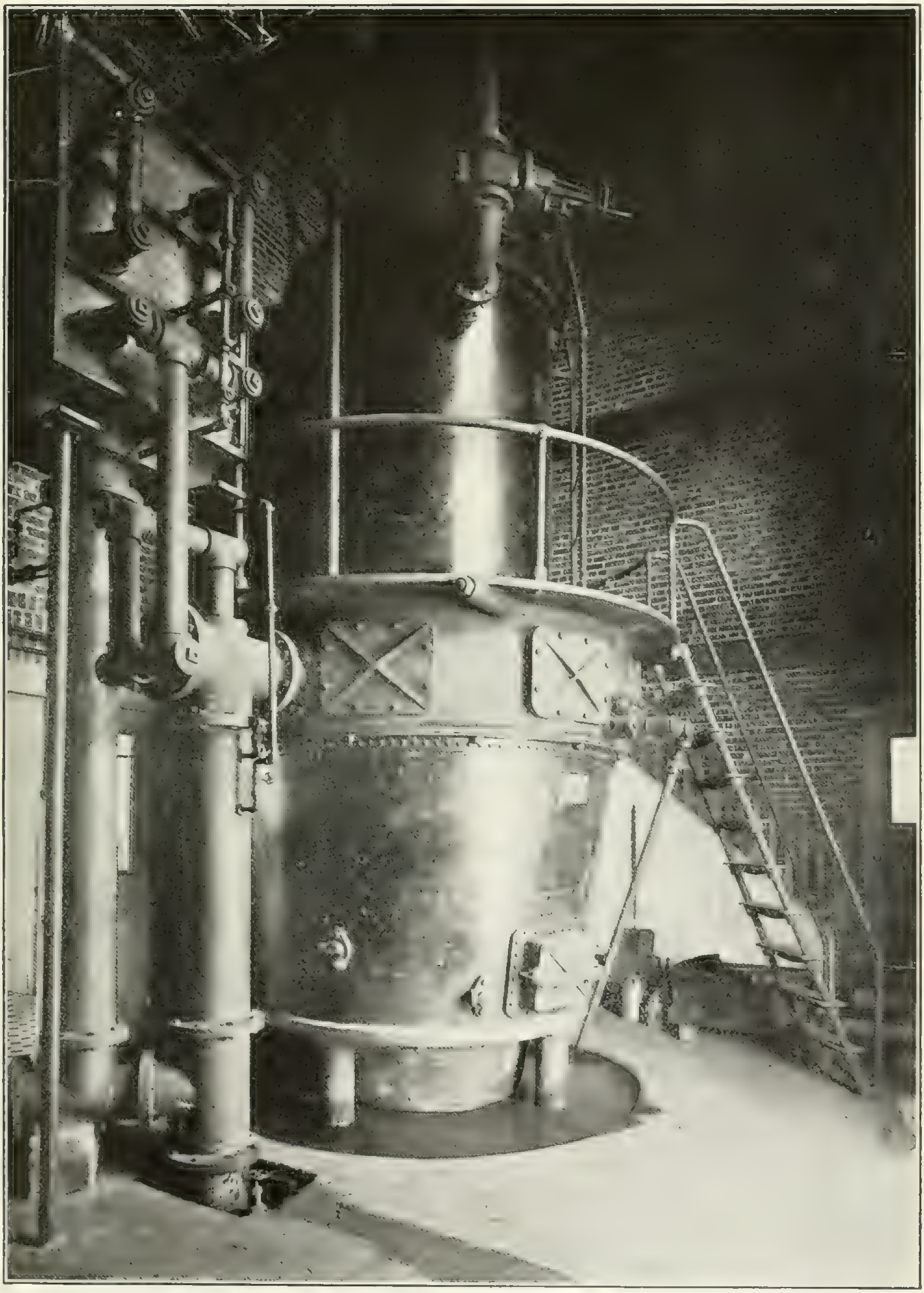


General arrangement of Westinghouse double zone suction bituminous gas producer for the use of bituminous coal and lignite.



Gas receiver and motor exhauster set of the 125 h.p. Westinghouse suction bituminous gas producer installed in the Fuel Testing Station, Ottawa.

Plate IV.



125 h. p. Westinghouse suction bituminous gas producer installed in the Fuel Testing Station at Ottawa.

26a p. 52

FUELS AND FUEL TESTING DIVISION.

B. F. Haanel, B.Sc., Chief of Division.

The work of this Division during the past year comprised: the completion of the tests with peat in the Körting peat producer gas plant; the chemical analysis and determination of the heating values of many samples of coals and peat, in addition to the regular chemical work carried on in conjunction with the producer trials; the delimitation and examination of several peat bogs in the Provinces of Ontario and Quebec, and the manufacture of peat at the Alfred peat bog.

New Equipment.—A Westinghouse double zone bituminous suction gas producer of 125 H.P. capacity has recently been installed (see Plate II). This producer is designed for the use of all kinds of bituminous coals and lignites and delivers a gas, free from tar (without any accessory cleaning apparatus), such as coke scrubbers, tar extractors, etc. Several plants of this type using coking bituminous coal and lignite, are in successful operation in the United States.

During the coming season a series of trials will be carried out with the bituminous coals and lignites mined in Canada, for the purpose of determining the suitability of these fuels for the production of power in a commercial producer gas power plant.

RECONSTRUCTION OF KÖRTING PEAT GAS PRODUCER AND GAS-CLEANING SYSTEM.

The peat gas producer, as originally designed and erected, did not successfully burn or decompose all the tarry matter distilled from the peat; during the trials previously carried out, the tar carried past the gas-cleaning system was deposited on the admission and mixing valves and in the cylinder of the engine. This caused the valves and piston rings to stick, and consequently interfered with their proper working. To overcome this difficulty, it was found necessary to wash the cylinder with oil, soap, and water, and to apply gasoline to the valves one or more times during a ten-hour run. The operation of the plant was satisfactory in every other respect.

At the conclusion of the above-mentioned trials the Körting Brothers of Hanover, Germany, were informed of the failure of their producer to deliver a clean gas, as a result of which they requested the Department to send ten tons of peat to their works for the purpose of experimentation. After considerable investigation with a producer of different construction, they reported that the difficulty had been completely overcome.

One of their producer experts was, consequently, sent to Ottawa to make the necessary alteration and carry out a test trial. The expense thus incurred (including the payment for and shipment of the 10 tons of peat to Hanover, Germany) was entirely borne by the manufacturers.

The trials conducted by the Körting producer expert, showed that the producer had been manifestly improved, but that the trouble resulting from the deposition of tar had not been entirely eradicated. The technical staff of this Division, therefore, undertook a series of trials for the purpose of investigating not only the formation of tar, but the possibility of destroying this tar in the producer itself. As the result of their trials it was concluded that the tar could not be entirely destroyed in the producer itself, but must be removed in the cleaning system. After considerable experimenting, a cleaning system was devised which efficiently removed the bulk of the tarry matter from the gas.

The plant now gives entire satisfaction and can be operated for long periods—several weeks—without removing the valves for cleaning, or washing the cylinders of the engine during operation. The fuel consumption per B.H.P. hour when running at $\frac{3}{4}$ load, is between $2\frac{1}{2}$ and $2\frac{3}{4}$ pounds of peat with a moisture content of between 25 and 30 per cent, and the consumption of cooling and cleaning water is very low.

Whenever coal costs $4 per ton, and when peat can be laid down at the producer plant for about $2.50 per ton, this type of power-plant will prove economical, efficient, and satisfactory in every respect. With an advance in the price of coal, the operators of producer plants can afford to pay a correspondingly higher price for the peat.

All power-plants utilizing peat fuel should be located on or adjacent to suitable bogs, in order to take advantage of the lowest possible cost at which the peat can be obtained.

Such plants would, through transmission lines, deliver for lighting, power, and other purposes the electrical energy thus generated to towns, villages, and municipalities not too far distant from the bog.

COMPLETE REPORT OF PRODUCER TRIALS.

The complete report setting forth the full results of the trials carried out at the Fuel Testing Plant with the peat manufactured at the Victoria Road, Farnham, and Alfred peat bogs, is now ready for the press. This report will be fully illustrated and will contain detailed descriptions of the plant, including the gas engine, producer, and gas-cleaning system.

Subjoined herewith will be found a report dealing with the work carried out by the chemical laboratory of the Fuel Testing Station.

Results of the investigation of the various peat bogs situated in the Provinces of Ontario and Manitoba are also herewith submitted by the engineer in charge of that work.

MANUFACTURE OF PEAT AT ALFRED.

During the summer season of 1911, the manufacture of peat was carried on during a period of 93 working days. The total output during this time was 2,100 short tons gross, while the amount of peat, containing 25 per cent moisture, available for sale was 1,800 short tons. Of this tonnage 265 tons were sold to persons resident in the vicinity of Alfred, and 867 tons were shipped to Ottawa, Montreal, and other places. The balance is stacked on the field at the bog, and will be shipped to Ottawa from time to time for use at the Fuel Testing Station.

The cost of manufacturing peat at the Alfred bog will be dealt with in a bulletin now in the course of preparation.

INVESTIGATION OF PEAT BOGS.

A. Anrep, Jr., Peat Expert.

In the early part of the season of 1911, in accordance with instructions, I continued the operation of the peat plant at Alfred, Prescott county, Ontario. On May 26, the plant at the Alfred peat bog, in full working order, was placed under the management of Mr. Carl Bengtsson.

Early in June, I left Ottawa for Manitoba—with a party consisting of Messrs. A. H. A. Robinson, J. H. Hooper, H. F. Collier, and E. Ericsson—to undertake the investigation of peat bogs, in order to ascertain the extent, depth, and quality of the peat contained therein. This investigation was begun at Lac du Bonnet—about 60 miles east of Winnipeg, or 4 miles west of Lac du Bonnet station.

MANITOBA PEAT BOGS.

The peat bogs examined in Manitoba during the summer of 1911 were:—

(1) Lac du Bonnet peat bog, situated 4 miles west of Lac du Bonnet station on the Canadian Pacific railway, in township 14, range 10E.

(2) Transmission peat bog, situated 18 miles west of Point Dubois on the City of Winnipeg Power Construction railway, in township 15, ranges 11E—12E.

(3) Corduroy peat bog, situated 14 miles west of Point Dubois on the City of Winnipeg Power Construction railway, township 15, ranges 12E—13E.

(4) Boggy Creek peat bog, situated 12 miles west of Point Dubois on the City of Winnipeg Power Construction railway, township 15, ranges 12E—13E.

(5) Rice Lake peat bog, situated 7½ miles west of Point Dubois on the City of Winnipeg Power Construction railway, township 15, ranges 13E—14E.

(6) Mud Lake peat bog, situated 3 miles west of Point Dubois on the City of Winnipeg Power Construction railway, in township 15, range 14E.

(7) Litter bog (peat litter and peat fuel bog), situated 2 miles west of Point Dubois on the City of Winnipeg Power Construction railway, in township 15, range 14E.

(8) Julius peat litter bog, situated about 1 mile west of Shelley station on the Canadian Pacific railway, in township 12, range 12E.

ONTARIO PEAT BOGS.

The peat bogs examined in Ontario during the summer of 1911 were:—

(1) Fort Francis peat bog, situated west of Fort Francis, in the townships of Crozier and McIrvine, in the district of Rainy River.

(2) Crozier peat bog, situated southwest of Fort Francis, in township Crozier, in the district of Rainy River.

(3) Coney Island peat bog, situated on Coney island, in the Lake of the Woods, west of Kenora.

Such bogs as appeared to possess economic possibilities—either as producers of peat fuel or peat litter—were thoroughly investigated; other bogs, however, which appeared to promise neither of these commercial advantages, were not examined in such great detail.

RECONNAISSANCE EXAMINATIONS: MANITOBA.

Reconnaissance examinations were made of the following bogs in various parts of the Province.

(1) White Mouth or Transcontinental peat bog, situated 2 miles east of Whitemouth station, and traversed by the Canadian Pacific railway and Transcontinental railway, in townships 4-13, ranges 12E—14E.

(2) Plumm peat bog, situated 1½ miles southwest of Whitemouth station, traversed by the Transcontinental railway, in township 11, range 11E.

(3) Netley marsh, situated 1½ miles east of Netley station, in township 16, ranges 4E—6E.

(4) Clandeboye bog, situated 2 miles west of Clandeboye station, in townships 13-16, range 3E.

(5) Big Grass marsh, situated about 2 miles east of Gladstone station, in townships 14-18, ranges 10W—11W.

(6) Douglas peat bog, situated about 13 miles east from Brandon or ½ mile from Douglas station, in townships 9-11, ranges 14-17.

(7) McGreary marsh, situated west of McGreary station, in townships 20-22, ranges 14W—15W.

(8) Ochre River marsh, situated south of Dauphin lake, in townships 24-24, ranges 15W—16W.

(9) Dauphin marsh, situated west of Dauphin lake, in townships 25-27, ranges 17W—18W.

Regarding those bogs of which reconnaissance examinations were made, indications are that they are either too shallow or that they are composed of material unfit for manufacturing into peat fuel. Possibly in some parts comparatively small areas of peat fuel may ultimately be found; although the results of our investigations afforded no indication that such would be the case. Moreover, a very long time would be required for the thorough investigation of such large areas. Under the circumstances, and taking into consideration the present sparsely settled conditions of the country, it was not considered advisable to attempt a detailed examination of these larger areas.

These investigations were continued during the greater part of June, July, August, and part of September.

Detailed descriptions, delimitations, and maps will be published in a separate report.

CHEMICAL LABORATORY OF THE FUEL TESTING STATION.

Edgar Stansfield, M.Sc., Chemist.

The work of this laboratory still continues to be seriously hampered by the lack of suitable accommodation. Moreover, such will continue to be the case until a suitable laboratory is built and equipped; although recent alterations have made it possible to convert a room over the laboratory into a balance room and office—a change which distinctly alleviates the present trying conditions.

Apart from smaller apparatus and general supplies, the equipment of the laboratory has, during the present year, been augmented by the following additions:—

One Thwing pyrometer equipment, including an indicator with a three-point switch and a recorder capable of recording the temperatures at three different points; one Bristol pyrometer with indicator and recorder; one Bristol portable pyrometer for quick determination of high temperatures; one Smith recording gas calorimeter with sampling pump and motor; one Sargent tar determination apparatus; one ½ H.P. electric motor; one electric signal clock; one Sian constant temperature drying oven; an electric tube furnace for making ultimate, organic analyses, designed by E. Stansfield and made by the Dominion Electric Company; and a Jewel water still was fitted with an electric heating device.

In addition to the setting up and testing the above apparatus, the work done in connexion with this laboratory included:—

Analyses of the fuels charged and ashes removed, gas analyses, and determinations of the tar in the gas during the different gas producer tests; examination of a solution adapted for use in fire extinguishers and known under the trade name of "Pyrene"; an investigation into the methods for the determination of moisture in coal and peat, and also the effect of hot drying on the calorific value of peat.

In addition to the above, the following analyses of samples of coals were made in the laboratory: 16 samples from Jasper park, Alta.; 1 sample from near Saunders cache, Alta.; 6 samples from Edmonton, Alta.; 5 samples from England; 1 sample of Pocahontas coal, and 1 sample of coal from South America. Analyses of samples of peat were also made as follows: 1 sample of peat from Bergeronnes, Saguenay county, Quebec; 4 samples from Farnham, Quebec; 15 samples from Alfred, Ontario; 1 sample from near Alfred, Ontario; 1 sample from Fitzroy Harbour, Ontario; 1 sample from western Ontario; 15 samples from Manitoba. Four samples of peat litter from Manitoba were also analysed.

ORE DRESSING AND METALLURGICAL LABORATORY.

George C. Mackenzie, B.Sc.

The ore dressing and metallurgical laboratory has been in more or less continual operation throughout the year. A short description of this laboratory, its installation and purpose, will be found on page 48 of the Summary Report of the Mines Branch for 1910. No important changes have been made in equipment during the year.

Since the laboratory's installation, ten large and two small samples of magnetic iron ores, and one small sample of copper-nickel ore have been received, tested, and reported upon. Tests on two small samples of Goulais River ore, and two large samples from Wilbur, Ontario, were reported in the last summary. The present report will deal with seven of the remaining large samples and the small sample of copper-nickel ore.

Following is a list of the ores tested during the year:—

Name of ore and number of test.	Locality.	Shipped by.	Weight of shipment. Tons.
3. Robertsville..............	Lots 3 and 4, con. IX, township of Palmerston, county of Frontenac, Ontario.	The Ontario Exploration Syndicate, Wilbur, Ont.	5.
4. Culhane..................	N. ½, lot 21, con. VII, township of Bagot, county of Renfrew, Ont.	Thos. B. Caldwell, Esq., Lanark, Ont.	3.
5. Bathurst.................	Lot 12, range XVII, township of Bathurst, county of Gloucester, New Bruns.	The Canada Iron Corporation, Ltd., Montreal, Que.	15.
6. Nictaux-Torbrook, hematite vein.	County of Annapolis, Nova Scotia.	The Canada Iron Corporation, Ltd., Montreal, Que.	15.
7. Nictaux-Torbrook, shell vein	County of Annapolis, Nova Scotia.	The Canada Iron Corporation, Ltd., Montreal, Que.	15.
8. Goulais river........	Goulais River range, township 22, con. XII, District of Algoma, Ont.	The Lake Superior Corporation, Sault Ste. Marie, Ont.	15.
9. Nickeliferous pyrrhotite...	Nairn, Ont..............	David A. Poe, Montreal, Que.	5 pounds.
10. Natashkwan Iron Sands...	Natashkwan point, Saguenay county, Que.	Department of Mines, Ottawa.	8

DEPARTMENT OF MINES
MINES BRANCH
OTTAWA

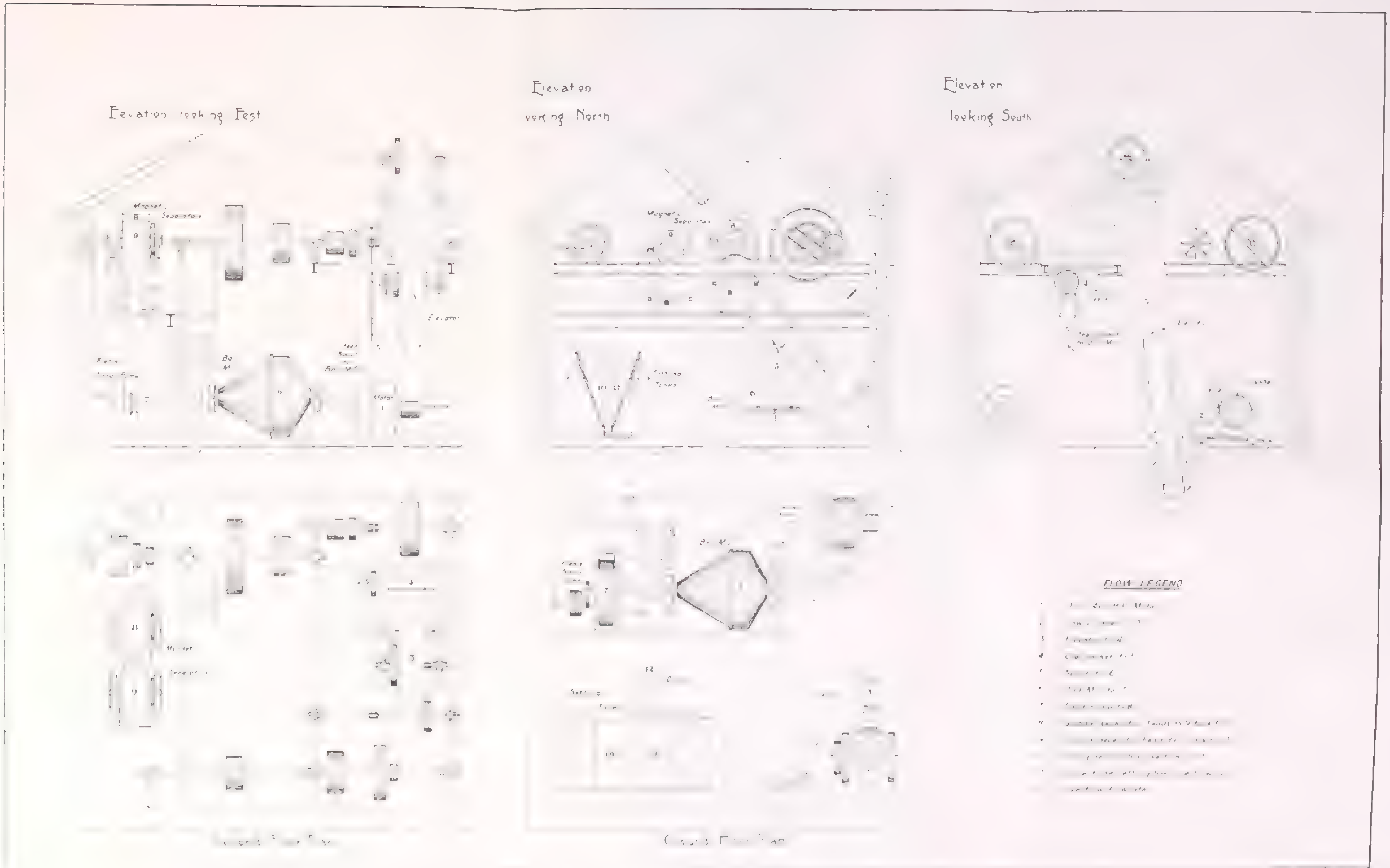


Fig. 5

ORE DRESSING LABORATORY

TEST No. 3.

Robertsville Ore, "Waste Dump."

Robertsville waste dump ore consists of crystalline magnetite irregularly distributed throughout a gangue of diorite country rock; a considerable amount of black hornblende and pink calcite with a smaller amount of white quartz is also associated with the magnetite.

The crystallization of the magnetite is rather coarse, and as the texture of the enclosing rock matter is granular and of somewhat friable nature, comminution and subsequent concentration is easily accomplished by the Gröndal system of separation.

Both sulphur and phosphorus are present in very small amounts in the crude. In the concentrate sulphur has disappeared entirely and the percentage of phosphorus cut in half.

The percentage of iron recovered is very satisfactory, being over 91 per cent of the original iron content of the crude. This is an important item in the concentration of such low grade material, and has a direct effect upon costs of production, more especially if the cost of the crude delivered at the mill should be above the normal. The test has shown that 2·74 tons of crude are required to make a ton of concentrate of 70·5 per cent iron content, when saving 91·81 per cent of the original iron. Now, if the percentage of recovery should drop to 90, there will be required 2·79 tons of crude to make a ton of 70·5 per cent iron concentrate; an addition of 0·05 tons of crude per ton of concentrate. At first glance this appears to be an inconsiderable loss, but if the crude is costing $1 a ton delivered it means an additional cost of 5 cents on the crude per ton of concentrate. In a mill of 1,000 tons daily capacity, this loss would amount to $50 every 24 hours.

Analyses of Crude Ore, Concentrate, and Tailing.

——	Crude Ore.	Concentrate.	Tailing.
Iron	28·00	70·5	3·6
Insoluble residue	50·70	3·1	
Sulphur	0·004	0·00	
Phosphorus	0·028	0·014	
Lime	3·30	0·000	
Magnesia	1·90	0·06	

From the above Analyses.

The units of crude required per unit of concentrate:—

$$\frac{70·5 - 3·6}{28·00 - 3·6} = 2·74$$

The percentage of iron in crude saved in the concentrate:—

$$\frac{100 \times 70·5}{28·00 \times 2·74} = 91·81$$

Units of tailing made per unit of concentrate: 1·74.

The percentage of iron in crude lost in the tailing:—

$$\frac{100 \times 3·6 \times 1·74}{28·00 \times 2·74} = 8·17$$

Gross tons of concentrate made per gross ton of crude: 0·364.

TEST No. 4.

Magnetic Concentration of Culhane Ore.

Culhane ore is a moderately fine-grained, crystalline magnetite, the gangue consisting of schistose material, calcite, and iron pyrites. The ore is extremely friable, the constituent minerals falling apart quite readily when rubbed with the hand.

Both sulphur and phosphorus are present in objectionable amounts, and as the iron content of the sample tested was under 48 per cent, the ore is distinctly a concentrating proposition.

Owing to the extremely friable nature of the ore, preliminary breaking with the Blake crusher was unnecessary, the ore being broken to egg size by hand and fed direct to the ball mill. It will be accepted, therefore, that Culhane ore is very easily pulverized, and this fact should have a decided effect on cost of treatment, since the comminution of the crude ore is one of the heaviest cost items in commercial magnetic separation.

Concentration has resulted in elevating the percentage of iron from 47·7 to 67, with a saving of over 95 per cent of the original iron content. Nearly 80 per cent of the sulphur in the crude has been eliminated. Phosphorus has not been reduced to the bessemer limit, but regarding the reseparation would probably yield a bessemer product.

Briquetting or nodulizing will be necessary to prepare the concentrate for blast furnace use, and either of these agglutinizing processes will yield a first-class furnace material practically free from sulphur.

Analyses of Crude Ore, Concentrate, and Tailing.

—	Crude.	Concentrate.	Tailing.
Insoluble residue	9·3	2·5	
Iron	47·7	67·0	6·6
Lime	4·2	0·10	
Magnesia	0·36	0·05	
Phosphorus	0·179	0·074	
Sulphur	1·65	0·357	

From the above Analyses.

The units of crude required per unit of concentrate:—

$$\frac{67 - 6{\cdot}6}{47{\cdot}7 - 6{\cdot}6} = 1{\cdot}47$$

The percentage of iron in the crude saved as concentrate:—

$$\frac{100 \times 67}{47{\cdot}7 \times 1{\cdot}47} = 95{\cdot}5$$

Units of tailing made per unit of concentrate = 0·47.

The percentage of iron in the crude lost in tailing:—

$$\frac{100 \times 6{\cdot}6 \times 0{\cdot}47}{47{\cdot}7 \times 1{\cdot}47} = 4{\cdot}5$$

Tons of concentrate made per ton of crude = 0·68.

MAGNETIC CONCENTRATION OF BATHURST, NICTAUX HEMATITE VEIN, AND NICTAUX SHELL VEIN, ORES.

Introductory Note.

All three of the ores tested for the Canada Iron Corporation are semi-magnetites, that is, they consist of a mineralogical mixture of magnetite and hematite.

The following magnetic concentration tests with these ores by the Gröndal process has shown that a fairly rich concentrate may be obtained, but only at the expense of a considerable loss of hematite in the tailing.

The recovery of iron and the purity of the concentrate produced, are factors depending on the degree of comminution to which the crude ores are subjected. Coarse crushing will effect a better saving of iron at the expense of the purity of the concentrate. Finer crushing will produce a purer concentrate, but will tend to increase the loss in iron.

Hence in the application of this process to the concentration of the ores under consideration, a point of economical recovery should be determined that will yield a concentrate at a cost figure commensurate with the initial value of the crude, and with the value of the concentrated product.

All concentrates produced by the Gröndal process will require nodulizing or briquetting.

TEST No. 5.

Magnetic Concentration of Bathurst Run of Mine.

Bathurst run of mine is a compact cryptocrystalline mixture of hematite, magnetite, and quartz. The ore possesses a somewhat laminated structure, although an alternate banding of the hematite, magnetite, and quartz is not apparent to the naked eye. Hematite and magnetite appear to be intimately associated in about equal proportions, the colour and streak of the ore varying from red to black, according to the proportion of ferric oxide.

Three tests were made on this ore, two of these being small preliminary tests and the third a final test. The first two were made with the view of arriving at suitable adjustment of the crushing and separating machinery. The final test was made at full capacity, and represents what may be expected from commercial practice.

The analyses of crude, concentrate, and tailing for each test are given below:—

—	Crude Ore.						Concentrate.						Tailing.		
	Fe.	Insoluble.	FeO	Fe_2O_3	P.	S.	Fe.	Insoluble.	FeO	Fe_2O^3	P.	S.	Fe.	FeO	Fe_2O_3
Test No. 5*a* Preliminary...	47·1	17·5	14·9	50·7	0·816	0·050	60·2	9·3	24·2	59·1	0·356	Trace	38·8	10·2	44·1
Test No. 5*b* Preliminary...	46·9	18·0	15·2	50·1	0·780	0·136	57·3	10·0	23·0	56·3	0·380	0·054	38·7	10·9	43·1
Test No. 5*c* Final.........	48·7	16·9	18·1	49·4	0·760	0·127	60·3	7·7	23·8	59·7	0·350	0·046	38·2	9·6	43·8

It will be noted that a considerable percentage of iron has entered the tailings and, therefore, must be considered as loss. This unavoidable loss in iron is due to the

presence of hematite in the crude, which, being non-magnetic, readily entered the tailings. It may be suggested that a retreatment of the tails over ordinary concentrating tables would save a considerable portion of the hematite. This is open to doubt, however, from the fact that the hematite is slimed badly and its recovery in such condition is very difficult.

Concentration at a larger size, that is, with less comminution, would avoid to some extent this heavy loss of iron, but the concentrate produced would be of distinctly inferior grade.

If it is desired to produce a concentrate higher in iron and lower in phosphorus than the figures given for Test No. 3, it will be necessary to regrind this concentrate and reseparate. This would result in a further loss of iron, but would in all probability yield a bessemer product.

TEST No. 5A.—PRELIMINARY.

Analyses of Crude Ore, Concentrate, and Tailing.

——	Crude.	Concentrate.	Tailing.
Iron	47·1	60·2	38·8
Insoluble residue	17·5	9·3	
Ferrous oxide	14·9	24·2	10·2
Ferric oxide	50·7	59·1	44·1
Phosphorus	0·816	0·356	
Sulphur	0·050	Trace.	

From the above Analyses.

The units of crude required per unit of concentrate:—

$$\frac{60{\cdot}2 - 38{\cdot}8}{47{\cdot}1 - 38{\cdot}8} = 2{\cdot}57.$$

The percentage of iron in the crude saved in the concentrate:—

$$\frac{100 \times 60{\cdot}2}{47{\cdot}1 \times 2{\cdot}57} = 49{\cdot}73.$$

Units of tailings made per unit of concentrate: 1·57.
The percentage of iron in the crude lost in tailing:—

$$\frac{100 \times 38{\cdot}8 \times 1{\cdot}57}{47{\cdot}1 \times 2{\cdot}57} = 50{\cdot}32.$$

Tons of concentrate made per ton of crude: 0·389.

TEST No. 5B.—PRELIMINARY.

Analyses of Crude Ore, Concentrate, and Tailing.

—	Crude.	Concentrate.	Tailing.
Insoluble residue	18·0	10·0	
Iron	46·9	57·3	38·7
Ferrous oxide	15·2	23·0	10·9
Ferric oxide	50·1	56·3	43·1
Phosphorus	0·780	0·380	
Sulphur	0·136	0·054	

From the above Analyses.

The units of crude required per unit of concentrate:—

$$\frac{57·3 - 37·8}{46·9 - 37·8} = 2·14$$

The percentage of iron in the crude saved in the concentrate:—

$$\frac{100 \times 57·3}{46·9 \times 2·14} = 57·09.$$

Units of tailing made per unit of concentrate = 1·14.
The percentage of iron in the crude lost in tailing:—

$$\frac{100 \times 37·8 \times 1·14}{46·9 \times 2·14} = 42·91.$$

Tons of concentrate made per ton of crude = 0·467.

TEST No. 5C.—FINAL.

Analyses of Crude Ore, Concentrate, and Tailing.

—	Crude.	Concentrate.	Tailing.
Insoluble residue	16·9	7·7	
Iron	48·7	60·3	38·2
Ferrous oxide	18·1	23·8	9·6
Ferric oxide	49·4	59·7	43·8
Phosphorus	0·760	0·350	
Sulphur	0·127	0·046	

From the above Analyses.

The units of crude required per unit of concentrate:—

$$\frac{60·3 - 38·2}{48·7 - 38·2} = 2·105.$$

The percentage of iron in the crude saved in the concentrate:—

$$\frac{100 \times 60 \cdot 3}{48 \cdot 7 \times 2 \cdot 105} = 58 \cdot 83.$$

Units of tailing made per unit of concentrate: 1·105.
The percentage of iron in the crude lost in tailing:—

$$\frac{100 \times 38 \cdot 2 \times 1 \cdot 105}{48 \cdot 7 \times 2 \cdot 105} = 41 \cdot 17.$$

Tons of concentrate made per ton of crude: 0·475.

TEST No. 6

Magnetic Concentration of Torbrook "Hematite Vein," Run of Mine.

Torbrook hematite vein is composed of a hard compact ore, consisting of intermixed, finely crystalline magnetite and hematite, the latter mineral being, for the most part, of the specular variety. The gangue is predominantly siliceous, although lime and magnesia are present in small amounts. Hematite and magnetite exist in about the proportion of 1 to 2·6 respectively,[1] the colour of the ore being grey-black.

Three tests were made on this ore. Analyses of crude ore, concentrate, and tailing for the three tests are as follows:—

[1] This proportion is figured from analyses of crude in Test No. 3 and is made on the assumption that the 14·9 per cent of FeO exists only in combination with the mineral magnetite. This is probably incorrect, as part of the FeO will be found in combination with CO_2, forming iron carbonate.

	Crude Ore.								Concentrate.								Tailing.		
	Fe.	Insol.	FeO	Fe_2O_3	CaO	MgO	P.	S.	Fe.	Insol.	FeO	Fe_2O_3	CaO	MgO	P.	S.	Fe.	FeO	Fe_2O_3
Test No. 6*a* Preliminary.......	45·5	23·4	15·0	48·3	1·02	0·40	1·55	0·016	61·0	11·4	23·3	63·1	0·20	0·1	0·69	0·004	32·0	11·3	33·1
Test No. 6*b* Preliminary.......	47·8	22·2	14·1	51·4	1·36	0·20	1·50	0·020	61·3	10·4	21·7	63·4	0·30	0·05	0·64	0·004	32·4	7·3	38·1
Test No. 6*c* Final.	47·2	21·7	14·9	50·8	0·86	0·40	1·41	0·011	61·0	9·9	21·6	63·7	0·28	0·20	0·54	0·005	33·0	9·4	36·7

It will be noted that separation has had the effect of producing a concentrate 14 per cent higher in iron than the original crude, depressing insoluble matter to less than one-half, and phosphorus to about one-third of the percentages found in the crude. This was effected only with the loss of considerable iron in the tailing as hematite, the recovery of the original iron being 65·6 per cent.

A reconcentration of the tailing for the recovery of hematite would probably be uneconomical, as the hematite is in slimed condition, and, therefore, difficult to save.

TEST No. 64.—PRELIMINARY.

Analyses of Crude Ore, Concentrate, and Tailing.

—	Crude.	Concentrate.	Tailing.
	%	%	%
Insoluble residue	23·4	11·4	
Iron	45·5	61·0	32
Lime	1·02	0·20	
Magnesia	0·40	0·1	
Phosphorus	1·55	0·69	
Sulphur	0·016	0·004	
Ferrous oxide	15·0	23·3	11·3
Ferric oxide	48·3	63·1	33·1

From the above Analyses.

The units of crude required per unit of concentrate:—

$$\frac{61 - 32}{45 \cdot 5 - 32} = 2 \cdot 15$$

The percentage of iron in the crude saved as concentrate:—

$$\frac{100 \times 61}{45 \cdot 5 \times 2 \cdot 15} = 62 \cdot 36$$

Units of tailing made per unit of concentrate = 1·15.
The percentage of iron in the crude lost in tailing:—

$$\frac{100 \times 32 \times 1 \cdot 15}{45 \cdot 5 \times 2 \cdot 15} = 37 \cdot 64$$

Tons of concentrate made per ton of crude = 0·465.

TEST No. 6B.—PRELIMINARY.

Analyses of Crude Ore, Concentrate, and Tailing.

—	Crude.	Concentrate	Tailing.
	Per cent.	Per cent.	Per cent.
Insoluble residue	22·2	10·4	....
Iron	47·8	61·3	32·4
Lime	1·36	0·30	....
Magnesia	0·20	0·05	....
Phosphorus	1·50	0·64	....
Sulphur	0·020	0·004	....
Ferrous oxide	14·1	21·7	7·3
Ferric oxide	51·4	63·4	38·1

From the above Analyses.

The units of crude required per unit of concentrate:—

$$\frac{61\cdot3 - 32\cdot4}{47\cdot8 - 32\cdot4} = 1\cdot87$$

The percentage of iron in the crude saved as concentrate:—

$$\frac{100 \times 61\cdot3}{47\cdot8 \times 1\cdot87} = 68\cdot58$$

Units of tailings made per unit of concentrate: 0·87.
The percentage of iron in the crude lost in tailing:—

$$\frac{100 \times 32\cdot4 \times 0\cdot87}{47\cdot8 \times 1\cdot87} = 31\cdot42$$

Tons of concentrate made per ton of crude = 0·534.

TEST No. 6C.—FINAL.

Analyses of Crude Ore, Concentrate, and Tailing.

—	Crude.	Concentrate	Tailing.
	Per cent.	Per cent.	Per cent.
Insoluble residue	21·7	9·9	....
Iron	47·2	61·0	33·0
Magnesia	0·86	0·28	....
Phosphorus	1·41	0·54	....
Sulphur	0·011	0·005	....
Ferrous oxide	14·9	21·6	9·4
Ferric oxide	50·8	63·7	36·7

From the above Analyses.

The units of crude required per unit of concentrate:—

$$\frac{61 \cdot 0 - 33 \cdot 0}{47 \cdot 2 - 33 \cdot 0} = 1 \cdot 97$$

The percentage of iron in the crude saved as concentrate:—

$$\frac{100 \times 61 \cdot 0}{47 \cdot 2 \times 1 \cdot 97} = 65 \cdot 6$$

Units of tailing made per unit of concentrate = 0·97.
The percentage of iron in the crude lost in tailing:—

$$\frac{100 \times 33 \cdot 0 \times 0 \cdot 97}{47 \cdot 2 \times 1 \cdot 97} = 34 \cdot 4$$

Tons of concentrate made per ton of crude = 0·508.

TEST No. 7.

Magnetic Concentration of Torbrook "Shell Vein," Run of Mine.

Torbrook "Shell Vein" is very similar in physical characteristics to the "Hematite Vein," although the former is much more magnetic. The ore is siliceous, but contains considerably more lime than the hematite ore.

From the analysis of crude in Test No. 7*a*, the proportion of hematite to magnetite is calculated as 1 to 15, and the analysis of crude in Test No. 7*b* indicates that no free hematite is present. The analyses of the tailing, however, prove that free hematite does exist to some extent. For instance, if 8·1 per cent of FeO in the tailing is present as a constituent of true magnetite, it would mean that the tails contained 26 per cent of magnetite and only 6 per cent of hematite. That this is absurd may be proved by examination of the tails with a hand magnet.

It is evident, therefore, that part of the FeO is present in some other form than magnetite, probably as a constituent of iron carbonate ($FeO\ CO_2$). Iron carbonate being non-magnetic will escape with the tailing, constituting an appreciable loss, and (judging by the analyses) this loss may be mistaken for free magnetite in the tailing, unless the above explanation is understood.

Two tests were made with this ore. Analyses are as follows:—

	Crude Ore.								Concentrates.								Tailings.		
	Fe.	Insol.	FeO	Fe_2O_3	CaO	MgO	P.	S.	Fe.	Insol.	FeO	Fe_2O_3	CaO	MgO	P.	S.	Fe.	FeO	Fe_2O_3
Test No. 7*a* Preliminary......	41·7	19·0	16·8	40·8	3·96	0·75	1·00	0·015	59·8	8·3	25·7	56·8	0·28	0·32	0·61	0·005	27·7	11·3	27·0
Test No. 7*b* Final.	42·5	18·4	19·0	39·6	5·5	0·37	1·03	0·033	60·5	8·5	21·8	62·1	0·58	trace.	0·62	0·005	22·8	8·1	23·6

Concentration has increased the iron content from 42 to 60 per cent, has cut the percentage of insoluble residue in half, and depressed phosphorus from 1·0 to 0·6 per cent. The percentage of iron saved with this ore is 74·5, a considerable advance over the figures obtained for iron recovery in the tests on Bathurst ore, and Torbrook "Hematite Vein."

Reconcentration of the tailing for recovery of hematite would probably not be profitable.

TEST No. 7A—PRELIMINARY.

Analyses of Crude Ore, Concentrate, and Tailing.

—	Crude.	Concentrate.	Tailing.
	%	%	%
Insoluble residue	19·0	8·3	
Iron	41·7	59·8	27·7
Lime	3·96	0·28	
Magnesia	0·75	0·32	
Phosphorus	1·00	0·61	
Sulphur	0·015	0·005	
Ferrous oxide	16·8	25·7	
Ferric oxide	40·8	56·8	

From the above Analyses.

The units of crude required per unit of concentrate:—

$$\frac{59{\cdot}8 - 27{\cdot}7}{41{\cdot}7 - 27{\cdot}7} = 2{\cdot}3$$

The percentage of iron in the crude saved in the concentrate:—

$$\frac{100 \times 59{\cdot}8}{41{\cdot}7 \times 2{\cdot}3} = 62{\cdot}4$$

Units of tailing made per unit of concentrate = 1·3.
The percentage of iron in the crude lost in tailing:—

$$\frac{100 \times 27{\cdot}7 \times 1{\cdot}3}{41{\cdot}7 \times 2{\cdot}3} = 37{\cdot}6$$

Tons of concentrate made per ton of crude = 0·435.

TEST No. 7B—FINAL.

Analyses of Crude Ore, Concentrate, and Tailing.

—	Crude.	Concentrate.	Tailing.
	%		%
Insoluble residue	18·4	8·5	
Iron	42·5	60·5	22·8
Lime	5·5	0·58	
Magnesia	0·37	trace.	
Phosphorus	1·03	0·62	
Sulphur	0·033	0·005	
Ferrous oxide	19·0	21·8	8·1
Ferric oxide	39·6	62·1	23·6

From the above Analyses.

The units of crude required per unit of concentrate:—

$$\frac{60 \cdot 5 - 22 \cdot 8}{42 \cdot 5 - 22 \cdot 8} = 1 \cdot 91$$

The percentage of iron in the crude saved in the concentrate:—

$$\frac{100 \times 60 \cdot 5}{42 \cdot 5 \times 1 \cdot 91} = 74 \cdot 5$$

Units of tailing made per unit of concentrate = 0·91.
The percentage of iron in the crude lost in the tailing:—

$$\frac{100 \times 22 \cdot 8 \times 0 \cdot 91}{42 \cdot 5 \times 1 \cdot 91} = 25 \cdot 5$$

Tons of concentrate made per ton of crude = 0·523.

TEST No. 8.

Magnetic Concentration of Goulais River Magnetite Iron Ores.

The Goulais River ore is extremely fine-grained. It consists almost entirely of a mixture of silica and magnetite alternating in narrow bands, the two constituents varying in their proportions widely. The leaner bands of quartz contain considerable iron, and the richer bands of magnetite appreciable amounts of silica.

The crude ores are low in iron, the Blue Cross sample carrying 33·9 per cent, and the Black Cross sample 36·8 per cent. Hence, to render the ores of economic value, concentration of the iron content and elimination of silica is necessary. Sulphur exists in only a small amount, 0·056 and 0·05 per cent, respectively.

Two methods of concentration suggest themselves as of possible practicability in bringing the ore up to a merchantable grade. First, to grind the ore to about 8 mesh and pass the product over a dry magnetic separator, using comparatively weak magnets so that only the highest grade of the ore would be separated as concentrate. This would, from the nature of the ore, entail a heavy loss of iron in the tailings. However, analyses of the separate sizes of the concentrate show that an iron content of only about 45 per cent is probably the best which could be expected.

The second method is concentration by the Gröndal process with very fine grinding, which is necessitated by the extremely fine state of division of the magnetite and gangue.

A preliminary run gave a concentrate of 53 per cent iron, with 6 per cent of iron in the tails. The screen test on the ball mill discharge from this run showed that 76 per cent passed 150 mesh; analyses of screen tests on concentrate product showed that material which passed 200 mesh carried over 60 per cent iron, whereas that which remained on the 150 mesh contained only about 42 per cent. On this account, it was decided to try the effect of regrinding the concentrate in a pebble mill. This dual grinding and separation is the method used at Sydvaranger, in Sweden, where ores of a somewhat similar nature occur, though in the Sydvaranger plant the first grinding in the ball mill is not so close as was that of the Goulais River ore.

The retreatment of the first concentrate did not bring about the expected benefit. The first concentrate from the test reported below gave a product carrying 50·5 per cent iron, with 4·3 per cent in the tailings. This concentrate, reground so that 76 per cent passed 200 mesh and re-separated, showed an increase in iron content of only 3 per cent.

It is probable that, on account of the extreme fineness of the ground material, the particles of magnetite were swept up in such masses as to prevent free escape of the siliceous material.

In place of direct regrinding and retreatment of the concentrate, classification, or sizing with Callow screens might be advisable; in which case concentrate that had passed 150 mesh and assaying about 58 per cent Fe could be dewatered and sent to the briquetting plant. This product would constitute at least 50 per cent of the whole after allowing for a considerable inefficiency in screening.

The oversize might then be reconcentrated either with or without further grinding. Below is a summary account of the tests.

Analyses of Crude Ore, Concentrate, and Tailing.

—	Crude.	Concentrate.	Tailing
Iron	33·9	50·5	4·3
Insoluble residue	52·1	30·9	
Sulphur	0·056	traces.	
Phosphorus	0·090	0·046	
Lime	0·20		
Magnesia	0·10		

From the above Analyses.

The units of crude required per unit of concentrate:—

$$\frac{50 \cdot 5 - 4 \cdot 3}{33 \cdot 9 - 4 \cdot 3} = 1 \cdot 57$$

The percentage of iron in the crude saved as concentrate:—

$$\frac{100 \times 50 \cdot 5}{33 \cdot 9 \times 1 \cdot 57} = 94 \cdot 8$$

The units of tailings made per unit of concentrate = 0·57.
The percentage of iron in crude lost in the tailing = 5·2.

Sieve Test, with Analyses, of 1st Concentrate.

——	%	% Iron.
On 50 mesh	1·75	44·4
Through 50 on 60 "	1·43	45·8
" 60 " 70 "	2·03	41·7
" 70 " 80 "	0·30	41·3
" 80 " 90 "	2·54	40·5
" 90 " 100 "	2·85	42·6
" 100 " 120 "	1·63	41·0
" 120 " 150 "	4·58	41·5
" 150 " 200 "	17·31	46·3
" 200 mesh.	65·58	61·4
Total		100

Analyses of Products of Retreatment.

——	1st Concentrate.	2nd Concentrate.	Tailing.
Iron	50·5	53·5	5·7
Sulphur	Trace.	Trace.	
Phosphorus	0·046	0·047	
Insoluble residue	30·9	25·2	

From the above Analyses.

The units of 1st concentrate required per unit of 2nd concentrate:—

$$\frac{53{\cdot}5-5{\cdot}7}{50{\cdot}5-5{\cdot}7}=1{\cdot}067.$$

Units of crude required per unit of 2nd concentrate = 1·067 × 1·57 = 1·68, or 0·595 unit of 2nd concentrate per unit of crude ore.

The percentage of iron in the crude saved as final concentrate:—

$$\frac{100\times 53{\cdot}5}{33{\cdot}9\times 1{\cdot}68}=93{\cdot}9.$$

Units of tailings made per unit of 2nd concentrate by retreatment of 1st concentrate = 0·067.

Units of tailings made per unit of 2nd concentrate = 0·68, or 0·405 units of tails per unit of crude ore.

A further test was made upon another sample of the Goulais River ore, marked with a black cross. In this test, the effect of lowering the strength of the magnets in the reconcentration was tried.

Two and one-third tons of the ore were taken, but in this case the ball mill grinding was not carried to quite such a fine stage, 76 per cent passing 150 mesh, whereas in the preceding test 82 per cent passed that size.

The concentrates from this separation were reground so that 76 per cent passed 200 mesh. In reconcentrating, a current of 3 amperes at 110 volts was first tried, but this was found to be too low to give a separation, so the current was raised to 4·1 amperes upon the first magnet, and 4·2 amperes upon the second.

The result was only a small improvement in the iron content of the concentrate, and this with a much heavier loss of iron in the tailing.

Second Test on Goulais River Magnetite Ore Sample, marked with Black Cross.

Machines and adjustments as in previous test, except as stated below.

Mechanical Condition of Ball Mill Discharge.

First Grinding of Crude.			Regrinding of Concentrates.		
		%			%
On	20 mesh	0·6			
Through	20 on 30	0·8			
"	30 " 40	0·8			
"	40 " 50	1·8			
"	50 " 60	1·2	On	60 mesh	1·01
"	60 " 70	2·0	Through	60 on 70	2·01
"	70 " 80	0·8	"	70 " 80	0·2
"	80 " 90	1·6	"	80 " 90	0·8
"	90 " 100	2·01	"	90 " 100	1·2
"	100 " 120	5·21	"	100 " 120	1·41
"	120 " 150	6·41	"	120 " 150	5·23
"	150 " 200	11·62	"	150 " 200	11·47
"	200	65·13	"	200	76·66
		99·98			99·99

Current used upon magnets for first concentration:—

1st magnet, 5·2 amperes at 108 volts.
2nd magnet, 5·4 amperes at 108 volts.

Currents used upon magnets for reconcentration:—

1st magnet, 4·1 amperes at 110 volts.
2nd magnet, 4·2 amperes at 110 volts.

Analyses of Crude Ore, Concentrate, and Tailing.

—	Insoluble Residue.	Iron.	Phosphorus.	Sulphur.
Crude	50·1	36·8	0·096	0·050
Concentrate	26	54·1	0·046	Trace.
Tailing	....	6·6		
Reconcentration.				
Final concentrate	19·2	58·6	0·047	
Tailing	....	15·4		

From the above Analyses.

Units of ore required per unit of first concentrate =

$$\frac{54\cdot1-6\cdot6}{36\cdot8-6\cdot6}=1\cdot57$$

or 0·637 units of concentrate per unit of crude ore.

Units of ore required per unit of final concentrate =

$$\frac{58\cdot6-15\cdot4}{54\cdot1-15\cdot4}=1\cdot12 \text{ and } 1\cdot12\times1\cdot57=1\cdot75$$

or 0·571 units of final concentrate per unit of crude ore.

The percentage of iron in crude saved in the first concentrate =

$$\frac{100 \times 54 \cdot 1}{36 \cdot 8 \times 1 \cdot 57} = 93 \cdot 64$$

The percentage of iron in the crude saved in the final concentrate =

$$\frac{100 \times 58 \cdot 6}{36 \cdot 8 \times 1 \cdot 75} = 90 \cdot 99$$

Units of tails per unit of first concentrate = 0·57.
Units of tails per unit of final concentrate = 0·75.
The percentage of iron in crude lost in tailing, first concentration = 6·36.
The percentage of iron in crude lost in tailing finally = 9·01.

THIRD TEST ON GOULAIS RIVER MAGNETITE.

A third test was made with the view of producing a richer concentrate, by certain adjustments of the separators. Results of this test will be incorporated in a later report.

TEST No. 9.

Report on Magnetic Concentration of Pyrrhotite Ore, from Mr. D. A. Poe, Montreal.

The sample of ore submitted was heavily mineralized with pyrrhotite. The gangue, which is basic, shows serpentinization and similar changes of decomposition. Chemical analyses showed the pyrrhotite to contain a certain quantity of nickel and copper, though the usual minerals, pentlandite and chalcopyrite, which carry these elements, were not evident to the eye. On this account, an attempt to separate the nickel from the copper by mechanical means is not likely to meet with any practical success. A test by hand magnet, after crushing to pass a 40 mesh screen, showed this to be the case. The crude ore containing 2·84 per cent nickel and 0·76 per cent copper, gave a concentrate carrying 3·62 per cent of nickel and 0·70 per cent copper, which amounted to 68·3 per cent by weight of the original ore. The tailings show a slight increase in copper containing 0·89 per cent with 1·16 per cent of nickel.

So far as elimination of gangue alone, for the purpose of lessening smelter, freight, and other charges is concerned, magnetic concentration by means of a separator with very powerful magnets, such as a machine of the Wetherill type, would in all probability give a satisfactory saving of the nickel content, though the loss in copper would be considerable.

A roasting of the crushed ore which would save a subsequent roasting of the concentrates preparatory to smelting, would cause all the metallic contents of the ore to become magnetic, or, in case of water separation, would prevent loss from floating slimes. It is possible, however, that a counterbalancing loss might be caused by soluble sulphates formed in roasting, going into solution.

On account of the small amount of gangue present, judging from the sample sent, the treatment best adapted would be direct smelting after preliminary roasting, with bessemerizing of the matte and subsequent separation of the nickel and copper.

TEST No. 10

Investigation of St. Lawrence River Titaniferous Iron Sands.

During the months of July and August an examination was made of the magnetic iron ore beach sands at Natashkwan, county of Saguenay, Quebec.

The examination consisted in blocking out a grassy, dune area, 3 miles long and from 200 to 600 feet wide, behind the beach at Natashkwan point. This area was then sampled at 250 ft. intervals with ordinary sand augers, to an average depth of 16 feet. One hundred and fifty-eight holes were put down in the above area, a sample of sand from each hole being bagged and marked with its survey number and depth.

Samples were also taken in the bush behind the dune area, but as the ground was very wet, preventing any appreciable depth being attained with the augers, these samples are not regarded as reliable. Samples were taken from the banks of the Great Natashkwan river, above the first falls, 12 miles from the mouth. These samples, although not rich in iron, indicate that the beach deposits have originated from the gradual breaking down of deposits of titaniferous iron ore in situ, said to be 50 miles up river.

In all, about eight tons of samples were accumulated and shipped to Ottawa for analyses and magnetic separation tests. The methods employed in resampling each bag of sand and in carrying out magnetic separation tests are as follows:—

Each bag of sand was dried to bone dryness and cut down to 100 grammes on a Jones sampler. The balance of the sand from each bag was then weighed in a measured box to ascertain its weight per cubic foot. It was then rebagged for subsequent Gröndal magnetic separation.

It should be remarked that the taking of an average sample of the dry sand is not an easy matter. The ordinary method of coneing and quartering would have been very inaccurate, inasmuch as the particles of magnetite and ilmenite accumulate at the bottom of the cone, repeated coneing and mixing simply making matters worse. Therefore, the Jones sampler was employed throughout the tests, and although the results do not indicate close accuracy they are sufficiently reliable for this class of work.

Each sample of 100 grammes, representing its respective bag of sand, was then tested for percentage of magnetic concentrate by means of an ordinary horse-shoe magnet. These separation tests were made under water, the percentages obtained representing percentages of magnetic concentrate for respective bore-holes.

Tabulated data for all bore-holes are as follows:—

NATASHKWAN MAGNETIC IRON SANDS.

Percentages of Magnetic Concentrate and Weight per Cubic Foot.

Bore-hole.	Depth of Hole.	Concentrate.	Weight per cub. ft. of Crude Sand.
Number.	Feet.	Per cent.	Pounds.
1	21	3·5	99·5
2	19	2·0	98·5
3	18	7·0	99·5
4	20	4·5	101·5
5	14	1·5	97·5
6	18	5·5	106·0
7	16	4·5	99·5
8	21	5·0	104·5
9	18	12·0	114·0
10	16	2·5	99·5
11	19	3·0	98·5
12	21	9·0	106·0
13	13	2·5	103·5
14	17	4·0	100·5
15	21	6·0	100·5
16	13	2·0	95·5
17	14	20·5	126·0
18	20	7·5	105·5
19	13	2·0	99·0
20	17	9·0	105·5
21	18	6·0	99·5
22	10	4·0	100·5
23	16	8·0	109·0
24	18	7·5	100·5
25	11	4·5	105·5
26	15	8·5	103·5
27	20	2·5	97·5
28	11	5·5	101·5
29	15	9·0	106·5
30	15	18·5	105·5
31	12	2·5	107·5
32	14	14·5	121·5
33	17	6·5	107·0
34	12	3·0	108·0
35	17	22·0	131·5
36	18	10·5	106·0
37	13	6·0	107·5
38	17	16·5	125·5
39	20	10·0	116·5
40	15	3·0	101·0
41	16	13·5	119·0
42	17	8·5	110·0
43	15	7·5	109·0
44	16	16·5	119·5
45	18	3·5	108·5
46	13	10·5	112·5
47	15	23·0	123·5
48	22	3·0	95·5
49	13	11·0	114·5
50	18	7·0	107·0
51	21	5·0	102·5
52	14	17·5	120·0
53	15	24·0	128·0
54	19	7·5	106·0
55	15	14·0	116·0
56	20	10·5	106·5
57	13	5·0	101·5
58	21	2·0	101·5
59	20	9·5	115·5
60	18	7·0	107·5
61	20	15·0	118·0
62	21	16·5	115·5
63	13	15·5	115·0
64	19	12·5	123·5

NATASHKWAN MAGNETIC IRON SANDS.—*Continued.*

Percentages of Magnetic Concentrate and Weight per Cubic Foot.

Bore-hole.	Depth of Hole.	Concentrate.	Weight per cub. ft. of Crude Sand.
Number.	Feet.	Per cent.	Pounds.
65	20	7·5	113·5
66	21	3·5	98·0
67	16	12·0	112·5
68	20	5·0	106·5
69	20	5·5	99·5
70	16	13·5	124·5
71	18	10·5	107·5
72	18	11·5	105·5
73	15	9·0	104·0
74	19	2·0	98·5
75	18	16·0	113·5
76	14	8·0	103·5
77	20	6·5	110·5
78	19	8·0	95·5
79	11	11·5	106·0
80	20	13·0	109·0
81	19	10·5	107·0
82	10	9·5	118·5
83	19	13·0	108·5
84	18	10·0	105·5
85	11	1·5	95·5
86	19	10·0	109·5
87	19	6·5	107·0
88	9	10·0	107·0
89	19	14·0	104·0
90	17	7·5	106·5
91	11	10·5	110·5
92	18	6·5	106·5
93	7	9·0	104·5
94	12	11·5	117·5
95	16	7·5	112·5
96	17	12·0	110·5
97	19	11·5	110·5
98	15	7·0	95·5
99	6	9·0	107·0
100	14	19·5	126·5
101	22	6·0	101·0
102	21	2·0	99·0
103	20	4·0	100·5
104	19	7·0	104·5
105	21	9·5	105·0
106	22	11·0	97·5
107	16	7·0	108·0
108	21	7·0	104·5
109	19	13·5	100·5
110	19	2·5	96·0
111	22	17·0	117·5
112	19	2·5	105·5
113	16	11·5	116·0
114	20	15·5	124·0
115	16	6·0	107·0
116	9	16·0	123·5
117	17	9·5	112·0
118	14	21·0	135·5
119	12	6·0	107·5
120	18	8·5	105·5
121	16	16·0	118·0
122	10	13·5	123·0
123	18	7·5	103·5
124	16	29·0	127·5
125	16	9·0	115·0
126	19	7·5	104·0
127	16	0·5	95·5
128	14·	15·0	115·5

NATASHKWAN MAGNETIC IRON SANDS.—*Concluded.*

Percentages of Magnetic Concentrate and Weight per Cubic Foot.

Bore-hole.	Depth of Hole.	Concentrate.	Weight per cub. ft. of Crude Sand.
Number.	Feet.	Per cent.	Pounds.
129	16	5·5	103·5
130	10	4·0	102·0
131	16	8·5	109·5
132	18	3·5	106·0
133	15	8·0	106·5
134	17	17·5	123·5
135	17	5·5	108·5
136	16	28·5	139·5
137	14	14·0	115·0
138	17	6·0	113·5
139	15	6·5	110·5
140	16	6·5	106
141	14	8·0	116
142	19	9·5	116·5
143	12	9·5	111·0
144	19	7·5	103·5
145	22	15·5	116·5
146	9	3·0	102·5
147	10	3·5	100·5
148	14	5·5	106
149	22	6·5	99·5
150	18	7·5	108·5
151	11	4·5	100·5
152	16	23·0	126·5
153	13	6·5	110·5
154	16	11·5	114·5
155	5	12·0	110·0
156	14	10·0	114·0
157	10	3·5	100·5
158	14	18·0	119·5

Arithmetical averages of the above results are as follows:—

Depth of Hole.	Concentrate.	Weight of Crude Sand.
Feet.	Per Cent.	Pounds.
16·3	9·45	109·75

It will be noted that the weight per cubic foot of the dry sand does not vary according to the percentage of magnetic material. This may be accounted for by the fact that the percentages of ilmenite do not vary with the percentage of magnetite; a sample may contain much ilmenite and little magnetite, or vice versa.

Concentrates and tailings from the above hand separation tests were collected, sampled, and assayed, with the following results:—

———	Concentrates.	Tailings.
Fe	68·10	8·30
TiO_2	2·5	3·17
SiO_2	1·00	...
P	0·023	..
S	Trace.	....

CALCULATION OF TONNAGES IN DUNE AREA EXAMINED.

The dune area under examination was subdivided into blocks 250 feet wide and from 200 to 600 feet long. Sample bore-holes were put down at each corner and also at the mid-point of the two longer sides of each block, hence each block is represented by six bore-holes.

Based on the data on percentages of magnetic concentrate and weight per cubic foot of raw sand given on previous pages, calculations for tonnages of raw sand and magnetic concentrate were made, volumes being calculated by prismoidal formula.

A summary of the results of these calculations is as follows:—

Number of blocks	55
Total area	817,566 sq. yds. = 168·92 acres.
Total volume	4,443,892 cub. yds.
Average depth of bore-holes	16·3 feet.
Average weight of raw sand per cubic foot	107·5 pounds.
Total weight of raw sand	5,784,246 gross tons.
Total weight of magnetic concentrate	501,111 gross tons.
Average per cent of magnetic concentrate	8·66 per cent.
Average ratio of raw sand to magnetic concentrate	11·54 : 1.

The above figures show that at least 500,000 tons of magnetic concentrate, containing 68·10 per cent of metallic iron, may be recovered from an area of 168·92 acres, at an average depth of 16 feet.

This tonnage is disappointingly small and it is doubtful if it would be found profitable to work, especially under the adverse conditions that obtain on the coast. It is believed, however, that magnetic concentrate will be found below an average depth of 16 feet, and as several holes put down by previous investigators have proved magnetic concentrate at a depth of from 35-45 feet, it will be a safe assumption to consider 30 feet as the workable depth of the raw sand over the area of 168·92 acres. There is no intention to assume that 8·66 per cent of magnetic concentrate will be found over this area at the depth of 30 feet. This would, of course, about double the total tonnage of magnetic concentrate as recorded above. The proof of its existence would entail a test drilling of the whole area at short intervals to the aforementioned depth.

The above remarks refer only to a comparatively small, treeless area along the shore. Behind the grassy dunes lies a wooded country of from four to five times the size of the former. There is no well founded reason why magnetic concentrate should not be found under this wooded area also. The whole of Natashkwan point for some miles along the coast is made ground, the accumulated yearly deposits of sand

brought down from the interior by the Great Natashkwan river. As previously mentioned, it was found impossible to bore this wooded ground, as water prevented any appreciable depth being made with the sand augers. A reliable examination would require a well equipped sludge drill for taking accurate samples of the watery sands.

GRÖNDAL MAGNETIC SEPARATION TESTS.

The hand tests recorded on previous pages were made on samples of equal weight, *i.e.*, 100 grammes; it was, therefore, necessary to bring all bags of sand to an equal weight, in order that the Gröndal machine tests would compare with the hand tests. This was accomplished with the aid of the Jones sampler to ensure proper distribution of the magnetic particles; at the same time a general sample of the crude sand was obtained for analysis.

The crude sand was then fed through a 10 mesh screen to remove chips, grass, etc., and thence direct to the separators, with the following result:—

Analyses of Crude Sand, Concentrate, and Tailing.

—	Fe.	TiO_2	Insol. Res.	S.	P.
Crude sand	14·70	4·43	76·00	0·006	0·006
Concentrates	67·20	3·51	7·45	0·043	0·012
Tailings	8·30	4·70	.....	.....	.....

Weight of crude sand fed to separators	10,930 pounds
Weight of concentrate recovered	1,087 "
Percentage of concentrate recovered	9·95 per cent.
Ratio of crude sand to concentrate recovered	10·05 : 1

The above concentrate was then ground in the Hardinge pebble mill and fed again to the separators for reconcentration.

Analyses: 1st Concentrate; 2nd Concentrate; 2nd Tailing.

—	Fe.	TiO_2	Insol. Res.	S.	P.
1st concentrate	67·20	3·51	7·46	0·012	0·043
2nd concentrate	69·8	2·37	2·74	0·006	0·015
2nd tailing	43·5	11·62	.....	.....	.....

Weight of 1st concentrate fed to separators	1,064 pounds
Weight of 2nd concentrate recovered	890 "
Percentage of 2nd concentrate recovered	84·03 per cent.
Ratio of 1st concentrate of 2nd concentrate recovered	1·19 : 1

Recapitulation.

10·05 units of raw sand required per unit of 1st concentrate,
1·19 units of 1st concentrate required per unit of 2nd concentrate,
$\therefore$ 10·05 × 1·19 = 11·96 units of raw sand required per unit of 2nd concentrate,
or, raw sand yields 8·36 per cent of 2nd concentrate.

Calculation, from Analyses, of Iron Saved.

First concentration:—

$\frac{67{\cdot}20 - 8{\cdot}30}{14{\cdot}70 - 8{\cdot}30} = 9{\cdot}04$ units of crude required per unit of 1st concentrate.

$\frac{67{\cdot}20 \times 100}{14{\cdot}7 \times 9{\cdot}04} = 50{\cdot}5$ per cent iron saved.

Second concentration:—

$\frac{69{\cdot}8 - 43{\cdot}5}{67{\cdot}2 - 43{\cdot}5} = 1{\cdot}1$ units of 1st concentrate required per unit of 2nd concentrate.

$\frac{69{\cdot}8 \times 100}{67{\cdot}2 \times 1{\cdot}1} = 94{\cdot}42$ per cent of iron saved.

Percentage of original iron saved in second concentrate =

$\frac{50{\cdot}5 \times 94{\cdot}42}{100} = 47{\cdot}68.$

A recrushing and reseparation of the second concentrate was made in an effort to depress TiO_2 below 1 per cent. Analyses for this test are not yet completed.

A complete report on Natashkwan sands will be issued at an early date; this report will be illustrated and will contain much data that is unavailable at present.

ENLARGEMENT OF THE ORE DRESSING AND METALLURGICAL LABORATORIES.

The fact that the installation at Ottawa of the present testing plant for magnetic iron ores has met with evident approval and appreciation from men engaged in the iron and steel industry has led to the conviction that a considerable enlargement of plant will be of distinct value to the general mining and metallurgical industries.

A well equipped testing laboratory will enable officers of the Mines Branch to carry out test work and research investigation in connexion with the dressing and metallurgical treatment of various Canadian ores. The need of such a laboratory is apparent with the statement that no such experimental research plant at present exists in Canada.

The machinery already installed is crowded into a small room at the Fuel Testing Station to an extent that absolutely precludes the addition of more apparatus. This condition is, however, to be improved by the immediate construction of a substantial addition to the present building.

The new building, which will be under construction by the time this report is published, will have a floor space of 57 × 75 feet, and will contain, besides a large mill room, several laboratories for analytical work.

The milling machinery to be installed will, it is expected, consist of both standard and small sized units to meet various requirements, and, although some time may elapse before the equipment is completed along modern lines, the laboratory will eventually possess sufficient latitude and elasticity to cope with the more general demands of the mineral industry in Canada.

ORE DRESSING AND CONCENTRATING LABORATORY.

During the current year, general approval of the purpose and work of the ore-dressing and concentrating laboratory operated under the direction of the Mines Branch, has been expressed by the mining public. The conditions which appeared

to require the establishment of such a laboratory, as well as the results which it was hoped would be attained, have already been referred to in the Summary Report for 1910.

A scarcity in the domestic supply of high grade iron ore on the one hand, and extensive but as yet undeveloped deposits of low grade iron ore on the other, may, in a word, be considered as among the chief conditions which to-day confront the Canadian iron masters and determine the output of Canadian furnaces. By concentration of our lower grade ores, and by the elimination of such impurities as sulphur, phosphorus, and titanium, when present in excess, it is hoped that large iron deposits, which up to the present time have been considered as of little or no value, may become profitable sources of supply for our own blast furnaces.

During the year just closed, trial shipments of low grade iron ores were received from Robertsville, Goulais river, and Culhane, in the Province of Ontario; from the Natashkwan river, in the Province of Quebec; from the Gloucester iron deposits, in the Province of New Brunswick, and from the Nictaux-Torbrook deposits in Nova Scotia. Tests of these ores regarding their adaptability to concentration and purification, by means of the Gröndal magnetic separation, were carried out under conditions approximating, as nearly as possible, those of commercial practice. A sample of nickeliferous pyrrhotite from a deposit near Nairn, Ont., was also tested with a view to determining the treatment best adapted for extracting the nickel and copper content.

The above work was carried out in the ore-dressing laboratory of the Mines Branch under the direction of Mr. G. C. Mackenzie, and detailed results, as well as an outline of methods employed, will be found in his report. In addition to this work Mr. Mackenzie also spent a part of the field season in a systematic examination of the deposit of iron-bearing sands lying along the north shore of the St. Lawrence, near the mouth of the Natashkwan river. Previous investigation carried on at various times by different parties has resulted in a considerable divergence of opinion regarding the possible economic value of these sands. The enormous deposits which are known to exist, not only on the Natashkwan, but elsewhere as well along the lower St. Lawrence, render the accurate determination of their probable value a matter of considerable importance. Consequently the results of Mr. Mackenzie's work in the field and of the subsequent concentration in the laboratory of a shipment of the iron-bearing sands will be read with interest. It appears, however, that further investigation will be required to finally determine the commercial value of these deposits.

The work of the ore-dressing laboratory has, during the past year, been considerably handicapped owing to insufficient accommodation. Contemplated alterations in the plant will, it is expected, greatly improve conditions in this respect.

THE BUILDING AND ORNAMENTAL STONES OF THE MARITIME PROVINCES.

BY

Professor William Arthur Parks, B.A., Ph.D.

Acting upon instructions received from the Director, I spent three and a half months of the field season of 1911 in the examination of quarries in the Maritime Provinces and Quebec. Leaving Toronto on June 3, I was engaged in the Maritime Provinces until August 21 and spent the rest of the time in the Province of Quebec, arriving in Toronto on September 21.

The information obtained in New Brunswick, Nova Scotia, and Prince Edward Island will be used in the preparation of a Report on the Building and Ornamental Stones of the Maritime Provinces, which will form the third part of a monograph on the building and ornamental stones of Canada. The field work in Quebec was confined to the region north of the St. Lawrence river; the data obtained will be reserved until the southern part of the Province has been examined.

The economic production of stone for structural purposes in the Maritime Provinces is practically confined to granite and sandstone. A brief account of the condition of the industry is given below for each Province separately.

NEW BRUNSWICK.

Granite.—The red, pink, and grey granites of St. George and the black granites of Bocabec, in Charlotte county, are being quarried by several firms; the product is nearly all manufactured into monuments in the extensive mills at St. George. In this county also, there is a small and intermittent production of grey granite from the vicinity of St. Stephen.

Near Hampstead, on the St. John river, the so-called Spoon Island stone is worked in two extensive quarries by D. Mooney & Company, of St. John. Both pinkish and grey, rather coarse-grained stone is obtained which is employed for monuments, for building, and for the making of paving blocks.

The rough grey granite boulders which are so plentifully scattered over the area north of McAdam Junction, in York county, are cut into building blocks by different operators and employed for structural purposes in Woodstock and other towns.

Near Bathurst in Gloucester county, a coarse-grained granite is from time to time quarried for local use.

Sandstone.—Roughly speaking, the sandstones of New Brunswick may be classified into red, grey, olive-green, and brown types. An excellent red freestone is quarried near Sackville, in Westmorland county, by the Sackville Freestone Company. The formation at this point is very favourable for the profitable extraction of stone. Large quantities are quarried and dressed by a modern plant, the product, in many cases, being shipped to a distance.

True grey sandstones occur along the Gloucester coast of Chaleur bay; they are quarried by two companies for the making of grindstones. The cost of quarrying is, however, too great to allow this material being put on the market as a building stone.

Olive-green sandstone is quarried in Northumberland, Kent, and Westmorland counties.

The quarry region in Northumberland is situated on the Miramichi river, near Newcastle. Two firms are now actively engaged—the Miramichi Quarry Company, Quarryville, and Adam Hill, Cassilis. C. E. Fish, of Newcastle, proposes to reopen the old French Fort quarries at an early date.

In Kent county, olive-green sandstone is quarried near Notre Dame, on the Moncton and Buctouche railway, by Hall and Irving, of Moncton.

Westmorland county was for many years the chief seat of the freestone industry in New Brunswick. At the present time a great many of the old quarries near Shepody bay and Cumberland basin are idle. H. Read and Company are operating a quarry at Northport, and the Dorchester Stone Works have a small quarry on the point between the Petitcodiac and Memramcook rivers. Near Shediac, Dr. E. G. Smith is producing a stone which may be included in this class.

Brown sandstone is quarried by the Read Company, at Wood point, in Westmorland, for grindstones, and the Cape Bald Freestone Company, of Port Elgin, is getting out building blocks at Cape Bald, on the eastern coast of Westmorland.

Crystalline limestone is largely quarried for the manufacture of lime at St. John, with the incidental production of a small amount of rough building stone.

The pure white gypsum at Hillsborough, in Albert county, has, in the past, been employed as a decorative stone, but there is no production for that purpose at present. The porphyritic felsites of Passamaquoddy bay, the Tobique valley, and elsewhere may have a future value as decorative stone but they are not at present utilized.

NOVA SCOTIA.

Granite.—A greyish, coarse-grained, and porphyritic granite is quarried by several firms along the Northwest Arm, near Halifax. At Terrence bay, a coarser and lighter coloured type was quarried for the construction of the Bank of Commerce in Halifax.

On the west side of Shelburne harbour, in Shelburne county, a very fine grey granite was formerly obtained. The character of the stone and the excellent shipping facilities should encourage the further exploitation of this deposit.

At Nictaux, in Kings county, are extensive exposures of an excellent fine-grained grey granite resembling the famous stone from Barre, Vermont. The Middleton Granite and Marble Company, Thelbert Rice, S. Williamston, and John Kline, of Halifax, are quarrying this stone for structural and monumental purposes.

Sandstone.—The sandstones of this Province are, for the most part, of an olive-green or reddish colour, and are obtained more particularly in Cumberland and Pictou counties.

The most important quarry of red stone is that of the Amherst Red Stone Quarry Company, near Amherst. Two small operators are producing a reddish stone near River John, in Pictou county. At Toney river and other places along this coast, as well as at Whycocomagh and Judique, Inverness county, Cape Breton, there was a former production of red sandstones.

Olive-coloured sandstones were at one time extensively quarried along the coasts of Chignecto bay and Northumberland strait, in Cumberland, Pictou, and Antigonish. In Cape Breton they were obtained, more particularly, on Boularderie island and at points near Sydney. At the present time there are only two quarries worthy of mention here, although small amounts of stone are raised by other operators. The quarries of the Wallace Stone Company, at Wallace, in Cumberland county, have furnished stone for many of the chief buildings in eastern Canada, and are still in active operation. The Pictou Quarry Company, of Pictou, produces a fine grade of stone which rivals the Wallace product in popularity.

Metamorphosed Slate.—A hard stone of this character is quarried on the Northwest Arm below Halifax. The product is largely employed for purposes of rough construction and, in some few cases, has been used in buildings of a higher type.

Crystalline Limestone.—The demand for flux in the steel plants has led to the opening of very large quarries at Marble mountain and George river, in Cape Breton. Good exposures have in consequence been made which reveal the shattered nature of the formation. Although fair-sized pieces of considerable beauty could be obtained from time to time, there does not seem to be much promise of success in the operation of these quarries for marble. Variegated crystalline limestones of marble quality are known to occur at other points in Cape Breton: among these may be particularly mentioned Whycocomagh and Eskasoni. No positive evidence was obtained that these deposits are capable of economic working, as they are much covered by soil and present only isolated exposures.

Felsite-breccia.—Along the coast of Richmond and Cape Breton counties, and more particularly on the north shore of Scatari island, handsome, varicoloured felsite-breccias occur. Although this material could not be secured in very large blocks, pieces of sufficient size for many decorative purposes could be readily obtained. Somewhat less brilliant but still handsome felsites may be obtained at many points in Pictou, Antigonish, and Guysborough counties.

PRINCE EDWARD ISLAND.

The only stone suitable for building produced in this Province is a red and not very durable sandstone of the Permo-Carboniferous age. Small and unimportant quarries have been opened at many places, but the only production at present is from Swan's quarry, near Charlottetown.

In the Maritime Provinces, as in other parts of the country, the stone industry has suffered severely from the general introduction of cement for purposes of construction. Those quarries which formerly produced heavy stone of a coarse type for bridge building and other works of a like nature are practically all closed. The long haul by rail to the chief centres of consumption is a deterrent factor in the profitable working of the finer grades of sandstone. The failure of the numerous quarries about the head of the Bay of Fundy has been ascribed to the almost prohibitive duty imposed by the United States Government. This same factor has had much to do with the closing of the granite quarries at Shelburne. It is encouraging to observe that Wallace, Pictou, Sackville, Amherst, and Miramichi stone can be profitably quarried and shipped to points as far distant as Toronto. It should be remembered also that many of the old quarries at Mary point, Demoiselle creek, Boudreau, etc., were operated almost entirely without machinery. Strong companies with modern equipment might well be able to revive the industry in this district.

The granite quarries of Charlotte county are handicapped by the long haul by team into St. George, by the small scale on which operations are conducted, and by the fact that no outlet is found for the large amount of debris. The stone has been quarried for monumental or large structural work only: in consequence, immense piles of material have accumulated from which paving blocks and even building stone of fair size could easily be cut. It is stated that an effort is being made to form a company embracing the various interests. It is to be hoped that such an attempt may meet with success, for such a company could concentrate the quarrying, provide better means of transportation, and devise ways for the utilization of the smaller stone.

SUMMARY REPORT ON THE SUDBURY NICKEL FIELD.

Professor A. P. Coleman, Ph.D.

Owing to the increase in the world's demand for nickel the Sudbury region, which supplies more than 60 per cent of the whole output, is now receiving an unusual amount of attention. The two old companies are extending their mining operations and are increasing their known reserves of ore either by diamond drilling to determine the extent of deposits which they already own or, where possible, by acquiring new ones. In addition another company is developing hitherto unworked deposits in preparation for the erection of smelters and other works for treating their ores; and a fourth is on the look out for properties of value not yet controlled by the three companies earlier in the field.

Owing to these conditions and also to the further opening up of the region by roads and railways, it is evidently an opportune time to note the advances in the Sudbury nickel field, to revise the latest map of the district, now six years old, and to prepare a report bringing up to date our knowledge of this important mining region.

Under instructions from Dr. Eugene Haanel, Director of Mines, this work was undertaken during the summer of 1911: in continuation of my two previous seasons work in the same field, studying the relationships of the more important mines.

By way of preparation, advantage was taken early in the summer, of a visit to Europe, to examine the only regularly working nickel mine in Europe, at Evje, in Norway, and to inspect the smelter at Evje, and the refinery at Christiansand, where, under the management of Mr. Hybinette, the nickel and copper in the matte are separated and refined electrolitically. The process is apparently a commercial success, since the works are being enlarged. The Mond nickel refinery at Clydach, Wales, was visited also, by the kind permission of the Mond Nickel Company: where a totally different method of treating the matte (derived from the Sudbury region) has also become a commercial success, so that the plant is to be greatly enlarged.

On July 8, Sudbury was reached and plans were made to revise the map of the region prepared for the Bureau of Mines of Ontario in 1905, and to visit every mine, whether now working or not, and also all known prospects of promise.

As all the known deposits are more or less directly connected with the basic edge of a great synclinal sheet of norite merging into micropegmatite, the summer months, until the first of October, were devoted to an examination of this basic edge.

The work was begun at the Trillabelle mine, at the southwest end of the boat-shaped syncline, and was carried southwest past the Chicago and Sultana mines to Victoria mines, the property of the Mond Company. The mine is working upon two ore-bodies of comparatively small horizontal dimensions, but of astonishing continuity, since they have been followed downwards for 1,600 feet without a break, and promise to go on indefinitely. Victoria mine is by far the deepest mine in Ontario and is surpassed by only one or two in British Columbia.

From Victoria mine the basic edge was followed northeast to the Crean Hill mine, belonging to the Canadian Copper Company, where very interesting relationships are found, since the country rock to the south has been thrust over the norite along a gently inclined fault plane. In this process the greenstone of the country rock was greatly shattered and ores from beneath penetrated all the fissures. It is probably owing to this fact that more copper than nickel is produced by this mine, a very

unusual feature not observed elsewhere in the region except at the old Copper Cliff mine.

The small but wonderfully rich Vermilion mine, famous for its platinum and gold, lies a short distance southwest of Crean Hill. Northeast of Crean Hill the basic edge has disclosed no large ore-bodies for 6 miles, at which point Gertrude mine, the property of the Lake Superior Corporation, was worked some years ago. A mile and a half farther east is the Creighton mine, the largest operating nickel mine in the world, situated where a bay of the norite projects southeast into the country rock of granitoid gneiss. The Creighton has the richest ore of any large mine in the region, and now furnishes about half of the nickel of the world. The diamond drill has proved that the ore-body continues for a long distance beyond the present workings, so that there are large reserves of ore.

The next important group of mines is on the Copper Cliff offset, where the famous Copper Cliff mine, more than 1,000 feet deep, is no longer working; though No. 2, a larger pipe-like ore-body, is being worked a little to the north.

Farther to the northeast none of the mines are working except the Garson, 12 miles from Copper Cliff; but shafts are being sunk on the Frood, or No. 3, mine by the Canadian Copper Company, and on the Frood Extension by the Mond Company. Diamond drilling has proved that this long outcrop of ore dips toward the basic edge of the norite, and that the deposit is much the largest in the district, quite surpassing the Creighton in quantity, though not equalling it in grade of ore.

Diamond drill work has also been carried on at the Mount Nickel mine, north of the Frood, showing the presence of a good body of ore.

The Garson mine, recently opened up by the Mond Company, now produces more ore than the Victoria mine. Here, as at Crean Hill, a great fault has shifted and fractured the norite and greenstone, breaking them into large irregular blocks, between which the ore has been deposited; though here the fault plane is nearly vertical. Here, too, copper ore is unusually abundant, about equalling the nickel in amount.

On what may be called the Eastern Nickel Range two new finds have been made, and the diamond drill has shown that some of the old properties are of more importance than was suspected. The Whistle mine at the north end of the range is being rapidly developed, and has proved to contain a great amount of ore. It has been connected by the Nickel Range railway with the Northern Ontario Branch of the Canadian Northern.

Much diamond drilling is being carried out on properties of the Northern Nickel Range by the Dominion Nickel and Copper Company with some very encouraging results, and this range, now almost inaccessible except on foot, will probably soon be reached by a westward extension of the Nickel Range railway.

Following the basic edge of the norite from Bowell township southwest to the region of Trillabelle mine completes the circuit of the nickel-bearing eruptive. Along this portion ore has been found at four points, but there has been little advance in development for a number of years.

The work of the past summer has resulted in a large number of changes in the map of the nickel ranges, most of them, however, of small extent. The results of the work confirm the opinion held by geologists and most mining men, that the ore deposits are the result of magmatic segregation from the norite-micropegmatite sheet with which they are connected. It is of interest to find that almost all the development work now being done, especially the diamond drilling, is closely checked in accordance with the geological principles resulting from the theory mentioned above, so that the work of the geologists who mapped the region is of direct practical value to the mine owners.

Advances in the metallurgy of the ores are being made by the Canadian Copper Company in increasing the proportion of green to roasted ore smelted, giving an

approach to pyritic smelting, in the construction of a reverberatory furnace to treat fines and flue dust, and in the introduction of immense converters with a basic lining to replace the small acid-lined converters.

The Mond Company are now constructing a new and much enlarged smelter at Coniston, conveniently placed, with good railway connexions between their two producing mines.

The Dominion Nickel and Copper Company are developing their ore-bodies, some of which are now known to be large, so as to be sure of a plentiful supply before beginning a smelter.

In an unostentatious way the Sudbury mining district is making rapid and yet solid advances, and bids fair to be the most steadily prosperous metal mining region of Canada. The peculiar character of the ore-bodies which follow the margin of a great mass of eruptive rock dipping away to unknown depths, suggests that mining may follow them also to great depths, giving a permanency to the camp which cannot be hoped for in most other mining regions.

COPPER AND PYRITES.

Alfred W. G. Wilson.

PYRITES INDUSTRY.

The manufacture of chemicals and chemical products forms the most important group of the industries of any country. Sulphur is a mineral product which is basic to the chemical industries. Directly or indirectly, it enters into the manufacture of a vast number of products. It occurs native in certain regions of past or present volcanic activity. It also occurs in association with copper, iron, and other metals, forming sulphides of these metals; of these compounds, iron pyrites is an important commercial source of sulphur.

In Canada native sulphur occurs only as a mineralogical curiosity; the sulphides of iron and copper are, however, found in many places, and in some few localities they occur in bodies large enough to be mined profitably.

During the past two years many inquiries have been received from firms in the United States with respect to Canadian pyrites. A brief investigation, made about two years ago, while studying the copper industry of Canada, led me to recommend the preparation of a special bulletin on pyrites and its uses. The purpose of this bulletin was to stimulate our pyrite mining industry by drawing the attention of producers to the large market for this product which lies at their doors. It was also hoped that Canadian consumers of sulphur might be attracted to our home product and its possibilities.

The winter months of the year 1911 were spent in the compilation of this report on pyrites and its uses. Publication has been delayed by causes beyond the control of this Department. Advantage is being taken of this delay to revise and expand the text, and it is hoped that it will be published early in the present year.

During the year 1910, eight firms (six in Ontario and two in Quebec) were mining and shipping pyrites ores in Canada. During the past year only seven firms have been mining ore, but several of these firms have done extensive development work. No new properties have come into the market, though a good deal of prospecting work is under way.

The following table compiled from statistics furnished by Mr. John McLeish, Chief of the Division of Mineral Resources and Statistics, will serve as an index to the magnitude of the Canadian pyrites industry during the last six years.

Canadian Pyrites Industry, 1906-1911.

Calendar Year.	Production. Tons of 2,000 lbs.	Value in dollars.	Tons Exported.	Value.	Balance stocked or Home Consumption.
1906	42,743	169,990	26,050	65,349	16,693
1907	46,243	212,491	25,056	80,139	21,187
1908	47,336	224,824	17,283	96,600	30,053
1909	64,644	222,812	35,798	156,644	28,846
1910	53,870	187,064	30,434	110,071	23,436
1911	82,666	365,820	32,302	120,585	50,564

It is to be noted that in calculating tonnages for statistical purposes, the actual sulphur content is not considered. The sulphur content of Canadian pyrites ores varies from 32 to 50 per cent, the average being probably about 42 per cent.

Small amounts of foreign pyrites, chiefly Spanish ore, are imported into Canada, but these importations are lumped under the heading, "Ores all other," in the Canadian Customs returns, and no statistics are available to indicate the tonnage. The Canadian home consumption is probably fairly well represented by the difference between the production and the exports, as very few of the mines stock large quantities of ore.

Returns published by the United States Government show that in the year ending June 30, 1911, 894,281 tons (2,240 lbs. each) of pyrites ore, containing not less than 25 per cent sulphur, were imported. During the same period, the home production was in the neighbourhood of 200,000 tons, and the amount exported was very small; hence, the annual consumption of pyrites in the United States is in the neighbourhood of one million tons.

The greater portion of the pyrites ore imported into the United States comes from Spain and enters through Atlantic ports, Boston, New York, and Philadelphia chiefly. From some of these ports a considerable tonnage finds its way to chemical works located on or near the Great Lakes.

Data compiled in my office, and obtained by direct correspondence with United States' consumers indicate that there exists, at the present time, in the vicinity of the Great Lakes alone, a market for more than 200,000 tons of pyrites ore suitable for acid-making—nearly four times Canada's whole present annual production. A very considerable portion of this market is supplied by domestic ores, but no data are at hand to determine the proportion of domestic and foreign ores now used in the vicinity of the Great Lakes. We find from the reports of the Customs Department that more than half the Canadian pyrites which is exported finds its way to the eastern market in the United States; hence the tonnage which reaches the Great Lakes market from Canada is very small. Inasmuch as freight rates to lake ports from many Ontario points, at which pyrites deposits occur, are comparatively low, it would appear as if this market offers great possibilities to owners of pyrites deposits in that Province.

Pyrites suitable for acid-making should contain as much sulphur as possible. Pure pyrites contains 53·4 per cent sulphur. The greater number of acid-makers demand a product containing not less than 42 per cent sulphur; there are, however, a few large consumers who purchase ore as low as 37 per cent. Practically all purchasers demand that the ore be free from arsenic, though in certain fertilizer works, ore, otherwise desirable, will be accepted if the arsenic content does not exceed one per cent. The ore should also be free from copper, zinc and lead, lime and magnesia, fluorine, chlorine and selenium. Ore containing pyrrhotite, as well as pyrite, is not desirable, though it will be purchased by some consumers, if the sulphur content is not too low.

The present price on the New York market for domestic, non-arsenical pyrites is about 12 cents per unit of sulphur, f.o.b. railway, for furnace size. Domestic non-arsenical fines are quoted at rates between 10 and 12 cents per unit. Arsenical ore brings a slightly lower rate, while non-arsenical Spanish ore usually commands a higher price

At the present price of 12 cents per unit, ore containing 40 per cent sulphur would be worth $4.80 per ton f.o.b. New York. In the Great Lakes market, Canadian pyrites of suitable quality should command a slightly higher price. According to the last report of the Ontario Bureau of Mines, the average price, at the mine, for Ontario pyrites, during the year 1910, was $2.90 per ton. The average sulphur content of this ore is not given.

Contracts with consumers are usually made for periods varying from two to five years; a minimum sulphur content and a minimum tonnage delivery per month are usually specified. It may be an advantage to Canadian producers or prospective producers to know that I heard a number of complaints about irregular deliveries and too low sulphur. How well founded these complaints were, I am not able to say. However, it is necessary to remember that a reputation for promptness is highly desirable in obtaining and in holding a large and important market of this kind.

The very small margin, which remains for the producer between mining costs and receipts for a low grade ore like pyrites, often makes it difficult for some owners to carry development work far enough in advance of mining to ensure a regular output. The mining of pyrites ore will be profitable in itself, only where large tonnages are produced and marketed. The small producer, who places his product on the market instead of utilizing it in a plant of his own, not only has to be content with a smaller margin of profit, but he will have greater difficulty in keeping his ore up to grade; under such conditions it also will usually be difficult to maintain a uniform output. Consequently, the small producer must expect to have difficulty in marketing his product.

In this connexion, it might be pointed out that a Pyrites Producers' Association for marketing the output of various mines would materially aid a number of the smaller properties now in course of investigation and would be of advantage to the industry as a whole. It would also be found that such an association would be of benefit to owners and producers in a number of other matters where mutual support and co-operation are desirable.

Owners of pyrites properties will be interested to know that there is some prospect of the development of a larger home market for pyrites ores. The question of the utilization of pyrites ore in the manufacture of sulphide pulp is being investigated by a number of large paper manufacturers. This process is in successful operation in many European plants, and will probably be introduced into Canada in the near future if a regular supply of suitable ore can be guaranteed for a sufficiently long term of years. This subject will be discussed more fully in the complete report on pyrites and its uses.

THE COPPER INDUSTRY.

The field work of this season was confined to British Columbia. During the summer, visits were paid to all the operating mines and to all the smelters in British Columbia treating ores of copper. The shortness of the time available for field work made it impossible to visit the copper prospects and other properties around the head of the Portland canal and in the Yukon, where exploration and development work is in progress. For the same reason, many localities in British Columbia, where copper minerals have been discovered, but where mining development has not yet taken place, were omitted from the itinerary. The return journey was made through the United States for the purpose of visiting some of the larger copper-producing districts, such as Ely and Bingham Canyon. Visits were also made to several of the large concentrating plants and smelting works in Utah, Montana, and elsewhere.

British Columbia has been, for many years, Canada's most important producer of copper. For the year 1912 the statistical returns show a slight increase in the production over previous years. That this increase is not greater can be attributed in a considerable measure to the closing of the Crowsnest collieries during nearly eight months of the year because of a strike among the miners. Because of this strike, the three large smelting industries, operating in south central British Columbia, were compelled to import coke from Pennsylvania, with resultant higher costs per pound for the copper produced. About the middle of August, it became necessary for the smelter of the Granby Consolidated Mining and Smelting Company, at Grand

Forks, to shut down. The mines at Phœnix were also closed at the same time. Work at the collieries has now been resumed and the Granby Company's mines and smelter resumed operations late in the month of December.

Mining Industry.—Inasmuch as it is hoped that the report on the copper industries of Canada will be completed during the present year, it is not necessary to discuss the season's operations of the various copper-producing corporations. It may be noted, however, that the three largest operators, the Canada Consolidated Mining and Smelting Company, the Granby Consolidated Mining and Smelting Company, and the British Columbia Copper Company, were all engaged in exploring various undeveloped properties, with a view to the discovery of new commercial bodies of ore.

Probably the most important development work is that of the Granby Company at their Hidden Creek mines on Goose bay, Observatory inlet. Here, by a system of tunnels and supplementary diamond drilling, a large body of sulphide ore has been developed. A tonnage, estimated at about 6,000,000 tons of 2 per cent ore, or about 12,000,000 tons of 1·65 per cent ore, has been shown to be present. In addition, development work has shown a very considerable tonnage of ore of a higher grade—above 5 per cent—and a large tonnage of lower grade. A large force of men has been employed during the year on development work, and in preparing for the operation of the property on a large scale. It is altogether probable that a smelter will be erected at Granby bay to treat the ores from this mine.

The erection of a smelter at this point will be a matter of considerable importance to the owners of many prospects along the Pacific coast of British Columbia. There are numerous indications of copper ores at many points, and the possibility of marketing copper ores near at hand will undoubtedly stimulate further prospecting and may lead to the development of other important mines.

During the year extensive development work has also been in progress at the Britannia mines on Howe sound, and a very considerable tonnage has been mined and shipped. On Texada island the Marble Bay mine continued to ship bornite ore; exploration work was in progress at the Cornell mine and at the Little Billy. Some prospecting work was also in progress on several claims on the Queen Charlotte islands.

Smelting Industry.—During the year, three smelters were practically in continuous operation—Tyee Copper Company at Ladysmith, British Columbia Copper Company at Greenwood, and Canada Consolidated Mining and Smelting Company at Trail. The plant of the Granby Consolidated Mining and Smelting Company, at Grand Forks, was closed from the middle of August until about the middle of December, on account of a shortage of Alberta coke. Advantage was taken of the shut-down to make a number of alterations and improvements and to install a new plant for slag distribution. In brief, the slag is to be granulated by water and sluiced to central bins. From these bins, it will be elevated by belt conveyers to a transverse distributer belt which stands 120 feet above the present dump. By this means, the capacity of the present space available for slag dump will be greatly increased.

The plants of these operating companies will be described in some detail in the forthcoming general report.

A series of experiments in the use of oil for fuel have been in progress at Van Anda, Texada island, for some time. The Dominion Oil Smelting Company, of Vancouver, have erected an experimental oil-burning furnace in the building of the old smelting works at this point. This furnace is based on the patents of James J. Andersen. As the result of a series of experimental runs, the original construction has been remodelled. The plan and section of the remodelled furnace are shown in the adjoining sketches and will serve to give a general idea of its construction. Further details will be found in Canadian Patent, Number 104553. An experimental

run was made under the supervision of Thomas Kiddie, M.E., of Vancouver, in July, 1911. Mr. Kiddie reports that the cost of oil consumed should approximate 30 to 35 cents per ton of ore smelted, and he estimates the saving of labour costs at the furnace at 9 cents per ton of ore smelted.

After this run, the furnace was remodelled along lines recommended by Mr. Kiddie, and at another run, made in November, a fuel cost of 33·6 cents per ton was attained, Mr. W. C. Thomas, Metallurgist, of Vancouver, being in charge. Further experimental runs are contemplated.

I.

THE IRON ORE DEPOSITS ALONG THE CENTRAL ONTARIO RAILWAY.

E. Lindeman, M.E.

During the field season of 1911, the examination of the iron ore deposits along the Central Ontario railway was continued by the writer.

The points visited were as follows:—

Blairton mine—Lots 7 and 8, concession I, Belmont township.

Belmont mine—Lot 19, concession I, Belmont township.

Maloney mine—Lot 18, concession I, Marmora township.
Lots 12, 13, and 14, concession I, Marmora township.
Lot 17, concession II, Marmora township.

Seymor mine—Lot 11, concession V, Marmora township.

St. Charles mine—Lot 19, concession XII, Tudor township.

Horten mine—Lot 57, Hastings Road, Tudor township.
Lot 17, concession XI, Lake township.
Lots 19 and 20, concession IV, Lake township.

Baker mine—Lot 18, concession XVIII, Tudor township.

Emily mine—Lot 7, concession XIX, Tudor township.
Lot 8, concession XV, Tudor township.

Coe Hill mine—Lots 15, 16, concession VIII, Wollaston township.

Jenkins mine—Lots 17, 18, concession VIII, Wollaston township.
Lots 9 and 10, concession XV, Wollaston township.

Ridge—Lots 17, 18, concession II, Wollaston township.
Lots 16, 17, concession III, Wollaston township.
Lot 28, concession XXVIII, Chandos township.

Bessemer—Lots 1-5, concession VI, Mayo township.

Rankin property—Lot 10, concession IX, Mayo township.

Childs property—Lots 11, 12, concession IX, Mayo township.

Stevens property—Lots 13, 14, concession IX, Mayo township.

Kennedy property—Lot 17, concessions V and VI, Carlow township.
Lot 30, concession XIII, Dungannon township.

Bow lake—Lot 21, concessions X and XI, Faraday township.

During the summer magnetometric and topographical surveys were made of the following properties:—

Blairton mine.
Belmont mine (topography).

St. Charles mine.
Baker mine.
Ridge property.
Coe Hill mine.
Jenkins property.
Rankin " (topography).
Childs " (topography).
Stevens "
Kennedy "
Bow lake "

In this work the writer had the advantage of the able assistance of Messrs. W. M. Morrison and O. G. Gallagher.

LOCATION.—The iron ore occurrences covered by the season's field work are situated along the Central Ontario railway, between Central Ontario Junction and the village of Bancroft, the distance between these two points being 60 miles.

The distance of the various deposits from the railway varies from 12 miles down to a few hundred feet.

HISTORY.—Some of the iron ore deposits in Hastings and Peterborough counties have been known for many years, and as early as 1820 an attempt was made, at Marmora, to manufacture pig iron from magnetite, taken from Blairton mine.

The venture does not seem to have met with any success, however, and operations were discontinued.

In 1867, the Blairton mine was opened again and mining was carried on until 1877. In 1882, the building of the Central Ontario railway was commenced, with the object of opening up the numerous iron ore deposits of North Hastings. At this time mining operations were commenced at Coe Hill and in several other places, but it was soon found that the iron ore contained so much sulphur as to be unmarketable, and the mines were closed. In 1906, a part of the Bessemer and Barrys Bay railway was built, connecting the ore deposits at Bessemer with the Central Ontario railway at a point about 1 mile south of L'Amable station. Mining operations were carried on by the Mineral Range Iron Company, until the beginning of 1908, when the properties were leased to the Canada Iron Furnace Company.

This Company continued operations until April, 1910. In the spring of 1911, the Bessemer, Child, Coe Hill, and Blairton properties were acquired by a corporation known as the Canada Iron Mines, Limited. This new Company commenced mining operations at Bessemer in August, 1911, and intends to erect in the near future a magnetic concentration plant at Trenton for the treatment of their ores.

GEOLOGY.—The greater portion of the area is occupied by Archæan rocks, consisting of crystalline limestones interstratified with a series of gneisses and schists and intruded by various igneous rocks such as granites, syenites, diorites, and gabbros. On the denuded surface of these Archæan rocks the various sediments constituting the lowest beds of the Palæozoic series have been deposited. These latter are found in the most southerly portion of the area, covering the older rocks in the form of a more or less continuous sheet. The crystalline limestne of the district generally has a coarse texture, and is more or less impure, owing to the presence of various silicates. The rocks which have been classified as gneisses are probably all of sedimentary origin. They sometimes represent alterations of more or less highly argillaceous sediments, while others are rich in quartz and seem to appear to mark transitions to true quartzites.

Associated with the gneisses, and often passing into them, are dark-coloured basic schists, which have been grouped by Adams and Barlow under the general name

of amphibolite.[1] Their chief constituents are hornblende and feldspar, but pyroxene and biotite often take the place of the hornblende in part. Regarding the origin of this series, while some of the rocks very likely are altered intrusions cutting through the limestone, others are undoubtedly of sedimentary origin representing certain harder, more or less siliceous bands in the original limestone.

The granites of the area generally have a coarse texture and are grey to reddish in colour. They show for the most part a distinct foliation, though in many places the foliated structure gives way to a granitoid one, and every stage of transition, from a typical granite to granite gneiss, can be seen.

The syenites have a coarse texture and are of a reddish colour, their chief constituent being a red feldspar. They often seem to grade into the granite and granitic gneiss, and there seems to be good reason to believe that they are simply a differentiation phase of the granite magma.

The gabbros or diorites have all the character of great basic intrusions, and are generally perfectly massive. Like the granite and syenite they cut through the limestone and associated gneisses and amphibolites, sending dyke-like masses into them and holding inclusions of the same.

Ore Deposits.—The iron ores found in the district may be divided into three groups:—

(1) Magnetite occurring along or near the contacts of limestones and schists with various igneous rocks.

(2) Titaniferous magnetite.

(3) Hematite.

Of these groups the first is the most important. Titaniferous magnetites, occurring as magmatic segregations in the gabbro are known in several places throughout the district. Judging from the magnetic attraction, the extent of these deposits seems, however, to be very limited. Owing to this and their chemical composition, they are, therefore, at the present time, of no practical importance.

An average sample taken by the writer from Horten mine, lot 57, Hastings Road, of Tudor, gave the following analysis:—

Iron	46·60
Insoluble	29·00
Phosphorus	0·020
Sulphur	0·061
Titanium, TiO_2	10·00

Another sample taken from lot 17, concession XI, of Lake, gave:—

Iron	45·80
Insoluble	30·71
Phosphorus	0·009
Sulphur	0·070
Titanium, TiO_2	12·22

Hematite has in the past been mined from several places in the vicinity of Madoc, but all the old mines are now closed. None of these deposits have been examined by the writer.

Contact Magnetite Deposits.—This type of ore deposit occurs as steeply dipping lenses and irregular masses along or near the contact of crystalline limestones and associated schists with granite, syenite, or gabbro-diorite. Associated with the magnetite are numerous ferruginous silicates such as pyroxene, hornblende, epidote, and garnet. Usually a considerable amount of calcite is also present.

The following table shows the analyses of some of the magnetites belonging to this class:—

[1] See Memoir No. 6, of the Geological Survey, Canada.

Name of Mine.	Name of Township.	Lot and Concession.	Metallic Iron.	FeO.	Fe_2O_3.	Phosphorus P.	Sulphur.	Titanium TiO_2.	Lime CaO.	Magnesia MgO.	Alumina Al_2O_3.	Silica SiO_2.	Insoluble matter.	Manganese Oxide.
Blairton mine	Belmont	7, 8, con. I	50·10			0·046	1·423	0·10	3·52	1·64	1·73	9·88		
Belmont mine	"	19, con. I	51·20			0·032	0·371	0·10	1·87	3·93	0·25	12·10		
St. Charles mine	Tudor	19, con. XII	42·00			0·080	0·832						31·85	
Baker mine	"	18, con. XVIII	38·70			0·200	3·347						37·10	
Coe Hill mine	Wollaston	15, 16, con. VIII	47·30			0·018	2·215						30·90	
Jenkins mine	"	17, 18, "	35·30			0·054	0·522	0·10					46·08	
No. 4, Bessemer	Mayo	4, con. VI*	54·29			0·019	0·062		6·86	1·35	2·02	9·84		
No. 4, Bessemer	"	4, con. VI†	42·50			0·030	0·300		13·05	2·80	2·79	19·20		
Rankin property	"	10, con. IX	42·70			0·104	0·215	0·10	8·08	1·74	3·80	15·87	31·00	
Child property	"	11, con. IX	42·00			0·066	0·160	0·10	7·75	2·00	3·35	12·53	31·30	
Stevens property	"	13, con. IX	30·70			0·080	0·015						23·00	
Kennedy "	Carlow	17, con. VI	43·70			0·118	0·102						10·50	
Bow Lake "	Faraday	Lot 21, cons. X, XI	51·00	21·80	45·30	1·94	0·070	0·50	7·14	1·78	4·73	9·03		

* Average analysis of the shipping ore supplied by the Canada Iron Furnace Co.

† Average sample of discarded ore.

All the analyses, with one exception, represent average samples taken by the writer during the field work. It will be seen that the metallic iron content varies in these samples from 54 down to 30 per cent. The iron content of the ore varies considerably, however, within the same ore deposit. Thus we often find rich portions of the ore made up chiefly of magnetite embedded in others of considerably lower grade and composed of magnetite, amphibole, pyroxene, epidote, garnet, etc., while in other places again the gangue minerals predominate, practically to the exclusion of the magnetite. The best quality of ore averages about 54 per cent, but considerable cobbing would have to be done in order to keep the output of any of the mines up to that standard. A large percentage of the ore does not contain more than 30 to 45 per cent, while some contains less. The sulphur content of the ores is variable, but generally high, owing to the presence of iron pyrites, and occasionally, as at Coe Hill, of pyrrhotite.

In some cases the pyritous portions can be separated by cobbing the ore, while in others the sulphides are so abundant and so finely distributed throughout the ore as to render its elimination by such a process impossible. The phosphorus in the samples taken varies, with one exception, from 0·018 to 0·200 per cent.

Extent of Ore Bodies.—Owing to the lack of sufficient development, and to the exceedingly irregular character of the ore bodies, it is impossible, at present, to estimate with even an approximate correctness, the quantity of ore available in this district. It seems, however, that often the irregularity of the ore bodies has hardly been sufficiently recognized, since many property owners assume that the ore occurs in regular beds, and therefrom erroneously infer the continuity of the ore deposits between widely separated outcrops. Thus in some cases, most exaggerated estimates of the amount of ore available are formed. The same error seems to have been frequent in using the dip needle. If, for instance, a few high magnetic readings have been obtained in some places lying several hundred or even thousands of feet apart, it has often been assumed that a continuous bed of ore existed.

The fallacy of such a conclusion is evident. Reliable conclusions regarding the probable extent of the ore-bodies can only be obtained by taking systematic magnetic readings sufficiently close together and modifying and interpreting the data thus obtained in the light of other evidence, geological, or topographical.

Occurrences of magnetite are very common in the district. Indeed, they are so abundant that in certain areas they may be found on every lot, but only in a few places do the results of our investigation *indicate* the presence of ore in such a quantity as to render the deposits of economic importance. Among these the following deposits deserve special mention:—

No. 4 deposit at Bessemer.
Rankin and Child properties.
Blairton mine.
Belmont mine.
The Ridge property.

No. 4 deposit at Bessemer has been proved to a depth of 100 feet by actual mining, with all indications of a considerably greater depth. According to the magnetometric survey, the total length of this deposit may be estimated at about 1,000 feet, the western end extending 450 feet under Little Mullets lake. The area of this deposit is roughly estimated at 50,000 square feet.

On the Rankin property magnetite ore has been exposed by a stripping 300 feet × 68 feet. Most of the area is, however, heavily drift-covered, and no diamond drilling has so far been done; but, judging from the strength, continuity, and breadth of the magnetic area shown by the magnetometric survey of Mr. H. Fréchette, it would

seem very probable that both the Rankin and the Child properties contain ore-bodies of considerable proportions.

The total area of these two properties within which ore is likely to occur, is roughly estimated at 412,000 square feet. It is, however, impossible to say how large a percentage of this area is actually occupied by ore until further development has been done.

At the Blairton there are two ore-bodies of some importance. On the southern deposit ore has been mined to a depth of 125 feet from a large open pit.

The probable ore area of this deposit does not seem to exceed to any great extent the boundaries of the pit and is about 27,000 square feet. Diamond drilling has proved the ore to a vertical depth of at least 550 feet.

The other deposit has been opened up on the hillside near Crow lake. Judging from the magnetometric survey, the total length of this deposit may be estimated at about 500 feet, its northern end extending about 130 feet under the lake. On the hillside immediately west and south of the open-cut several strongly positive magnetic areas alternating with some strong negative ones indicate an irregular distribution of magnetite in the country rock. The total area within which ore is likely to occur in this part of the field is roughly estimated at 128,000 square feet.

Judging from the magnetometric survey made by Mr. B. F. Haanel, and confirmed by a few natural exposures, the probable ore area of the Belmont may be roughly estimated at 43,000 square feet. Considerable diamond drilling was done some years ago on this property, and seven drill-holes, cutting the ore-body, were sunk at angles varying from 45 to 90 degrees. The results of these diamond drill-holes are, however, not so promising as the magnetometric survey would indicate, but show nevertheless a limited amount of good magnetite, besides a considerable quantity of low grade ore suitable for magnetic concentration.

At the Ridge property the summer's investigation has disclosed several strongly magnetic areas, of which the two largest show an attraction of 60 degrees or more, over an area of about 37,000 square feet each. With no outcrops of ore available, it is impossible at present to foretell their economic importance; but the promising results of the magnetometric survey ought to stimulate further investigation of this property in the form of diamond drilling.

PROSPECT OF DEVELOPMENT.

Iron mining has in the past, with few exceptions, been rather disappointing in this district. In some cases this has been due to the high sulphur content of the ore, in others to the irregular character of the ore deposits and the intimate association of the magnetite with the surrounding gangue and country rocks. Hand-picking of the ore was, therefore, in most cases necessary. This not only increased the cost of mining, but was in some places of little or no use. From what the writer was able to ascertain during his field work, it seems unlikely that any one of the deposits in the district could at the present time be profitably mined without submitting the ore to a magnetic concentration process. It may be that no single deposit contains ore reserves large enough to warrant the erection of a concentrating plant of sufficient capacity to ensure the profitable working of such a process. But should further development confirm the expectation which the result of the investigation of some of the above-mentioned deposits indicates, it should be possible by a consolidation of some of these properties to carry on mining operations on a sufficiently large scale to make the erection of a large concentrating plant feasible. The ore of these properties is well adapted for magnetic concentration, but a large percentage will undoubtedly have to be crushed rather fine in order to get a satisfactory separation of the magnetite from the associated gangue-minerals.

II.

CALABOGIE IRON-BEARING DISTRICT.

During the summer of 1911, the iron ore deposits near Calabogie, in Renfrew county, were also examined by the writer. Magnetometric and topographical surveys were made of the following properties:—

Martel mine—Lot 13, concession X, Bagot township.
Lot 16, concession IX, Bagot township.
Lot 16, concession VIII, Bagot township.

Bluff Point mine—Lot 16, concessions X, XI, Bagot township.

Culhane mine—Lot 21, concession VII, Bagot township.

Black Bay mine—Lot 22, concession XI, Bagot township.

In this work the writer was assisted by Mr. N. D. Bothwell, who performed his duties in a highly satisfactory manner.

Location of the District.—All the above-mentioned ore deposits are situated within an area of about 25 square miles. The district is traversed by the Kingston and Pembroke railway, with Calabogie station situated at the issue of the Madawaska river from Calabogie lake. By a spur-line, about half a mile long, the Bluff Point mine is connected with the railway, while all the other mines are situated within a radius of 2¾ miles from Calabogie station. The distance from Calabogie to Sharbot Lake, the junction of the Kingston and Pembroke railway with the Canadian Pacific's Montreal-Toronto line, is 42·5 miles, and to Kingston 89 miles.

History.—Mining operations in the district were commenced in 1881 by an American syndicate, which did some development work on the property now known as the Bluff Point iron mine. During the following winter, the work was continued by the Calabogie Iron Company. The ore was hauled by teams over Calabogie lake to Barryvale, which was at this time the terminus of the Kingston and Pembroke railway. In 1883, the ore deposit known locally as No. 4, on lot 16, concession VIII, was opened up by sinking a shaft 45 feet deep. The mining operations ceased, however, in the autumn of the same year, but were resumed in 1886, when a shaft 300 feet deep, and passing through 8 feet of ore, was sunk on the Bluff Point property. In the autumn of 1886, the property was leased to the American Mining Company, which continued operations until the following year, when the mine was again closed down. In 1894, all the ore available in the stock-piles at the mine was shipped to Radnor, Quebec, by the Canada Iron Furnace Company. Since then mining operations were carried on from time to time until the year 1901.

The total amount of ore which is reported to have been shipped from the Bluff Point and No. 4 mines is about 9,000 tons.

The Culhane and the Black Bay mines were also opened up in the eighties. No shipment of ore was ever made from the Culhane mine, but from the Black Bay mine about 10,000 tons are reported to have been shipped. The ore-body had a width of 7 to 8 feet and was worked to a depth of 15 to 20 feet.[1] The ore ran about 52 to 53 per cent in metallic iron with a very low sulphur content.

The Coe mine, or, as it is now locally known, the Caldwell mine, on the east half of lot 16, concession IX, was opened up in 1883 by Mr. Coe, from Madoc, who operated the property under lease. Subsequently the property was bought by Mr. T. B.

[1] Report of the Royal Commission on the Mineral Resources of Ontario, page 36.

Caldwell, of Lanark, and a number of openings were made by the Hamilton Steel and Iron Company, which acquired a lease of the property. The amount of ore shipped from this property is reported to be about 10,000 tons. This had to be hauled about a mile and a half by road to the end of the spur-line at the Bluff Point mine.

From the Wilson, or Martel mine, about 4,000 tons of ore are reported to have been mined and shipped. The ore was of very good character, and the width of the deposit at a depth of 59 or 60 feet was about 9 feet.

Geology.—The area is chiefly made up of crystalline limestone associated with various schists and intruded by granites, syenites, diorites, and other dark-coloured, basic rocks. The general strike of the stratified rocks is northeast and southwest, with a dip varying considerably in different places. At the Bluff Point mine this is about 30 degrees towards the southeast; near the Calabogie station the layers are almost flat, while at the Culhane and Black Bay mines the formation dips towards the northwest at an angle of about 30 degrees.

Some of the chlorite and mica schists associated with the limestone, as for instance those at the Bluff Point mine, seem to be simply alteration phases of the limestone produced by the metamorphic action of the intrusive rocks, while others may represent altered argillaceous clayey bands interstratified with the limestone.

Ore Deposits.—The iron ore of the district consists of magnetite which occurs in lenses and irregular masses associated with the igneous rocks along or near their contact with the crystalline limestone. Generally the limestone forms one wall of the deposits while the other is made up of one or other of the igneous rocks. In the few places where the limestone can not be seen in actual contact with the ore, it is always found outcropping in the immediate vicinity of the same. The quality of the ore varies considerably, not only in the various mines but also within the same deposit, owing to the amount of gangue-rock present. In some cases ore consisting of almost pure magnetite is observed; in others the magnetite is found closely associated with hornblendic, micaceous, and chloritic material, and often a gradual or sudden change of rich ore into such a gangue rock takes place.

The following table gives a number of analyses representing average samples taken by the writer and analysed by Mr. H. Leverin, of the Mines Branch.

Locality.	Iron.	Silica.	Insol.	Alumina.	Lime.	Magnesia.	Phosphorus	Sulphur.	Titanium.
	Fe.	SiO_2		Al_2O_3	CaO	MgO	P.	S.	TiO_2
"Tommy R. pit," lot 16, con. IX, Bagot	38·30	.....	16 10	......			0·233	0·020	
"T. B. pit," lot 16, con. IX, Bagot	50 59	10·26	.....	4·82	3·33	5·86	0·289	0·012	0·25
"Holden pit," lot 16, con. IX, Bagot	60 91	4 60	.....	3·60	1·77	2·83	0·578	0·100	0·10
Campbell mine, lot 16, con. VIII, Bagot	47 86	10 60	.....	4·27	4 45	6 90	0·330	0·080	0·25
South half of lot 16, con. IX, Bagot	47·81	15 00	.....	3 85	4 86	7·05	0·390	0·015	0·25
Martel mine, lot 13, con. X, Bagot	58·71	7 10	.....	1 55	2·05	5 70	0·056	0·230	Trace.
Pluff Point mine*	59·50	9·10	..	4·80	0·01		0·170	0·160	
Culhane mine	47 70	....	9·3	..	4·20	0·66	0·179	1·65	
Black Bay mine	51·60	.....	15·85	...	.....		....	..	

* Average sample by Canada Iron Furnace Co.

It will be seen from the above table that the best quality of the ore averages about 61 per cent of iron, while in other places it does not average more than 47 per cent. The sulphur content varies from 0·012 to 1·65 per cent with the phosphorus ranging from 0·170 to 0·578 per cent, thus putting the ore in the non-Bessemer class.

Extent of Ore-bodies.—Judging from the magnetometric surveys, the ore deposits of the district are of an extremely irregular character. This has already been proved

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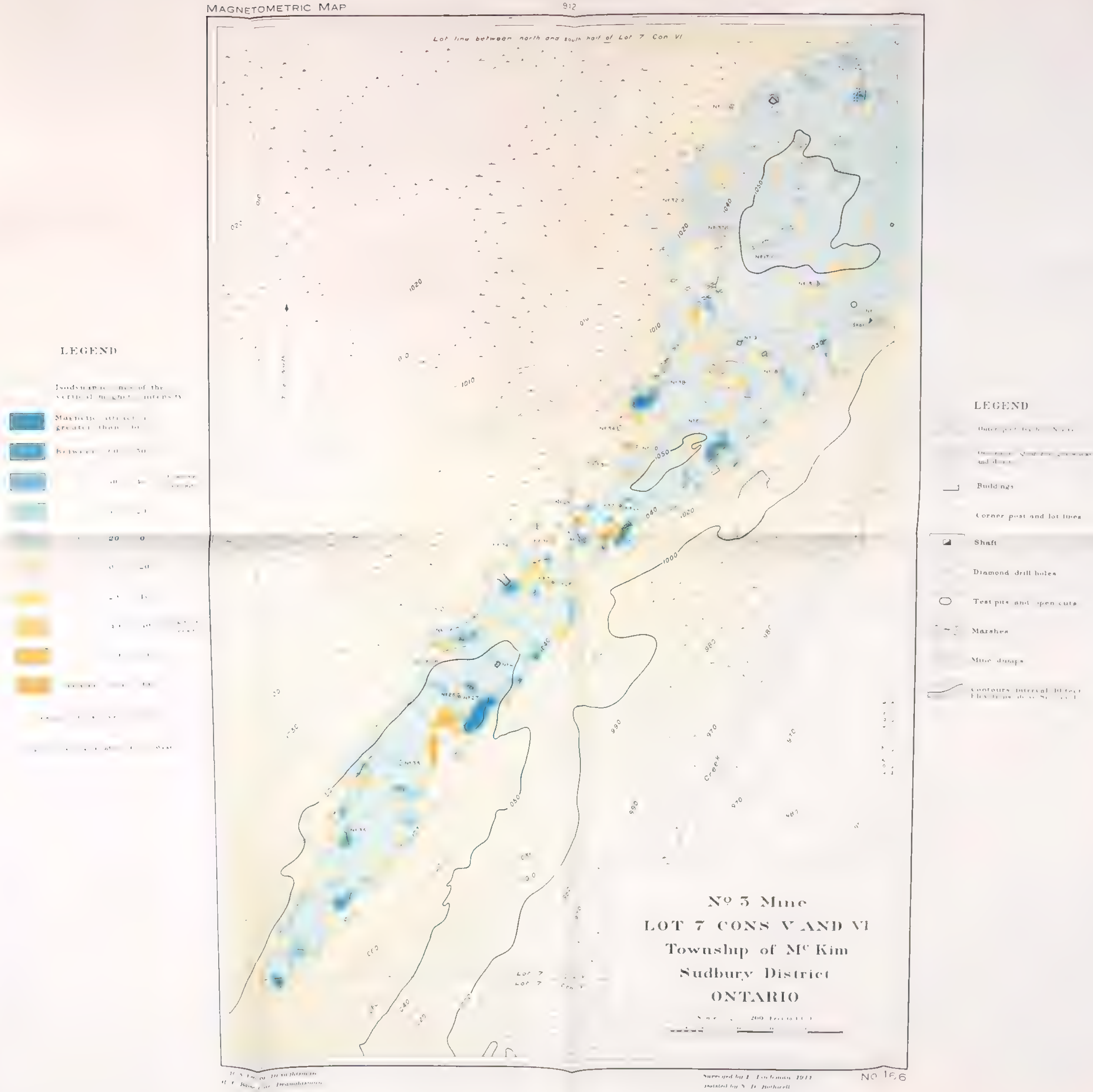
DEPARTMENT OF MINES

MINES BRANCH

MAGNETOMETRIC MAP 912



in many cases by actual mining work. In width the larger deposits vary from 1 to 12 feet with a maximum length of about 150 feet, while others are much smaller. It seems, therefore, that the district is not likely to become an iron-ore producer of any importance, though a limited amount of ore might yet be taken from some of the mines.

III.

MAGNETOMETRIC SURVEY OF A NICKELIFEROUS PYRRHOTITE DEPOSIT IN THE SUDBURY DISTRICT.

During the latter part of the field season of 1911, a magnetometric survey of No. 3 mine was made by the writer, assisted by Mr. N. D. Bothwell. This property is situated about 3 miles north of the town of Sudbury, on lot 7, concessions V and VI, in the township of McKim.

On this property a considerable amount of diamond drilling has been done during the last three years by the Canadian Copper Company, the results of which show the presence of a large deposit of nickeliferous pyrrhotite.

The object of the survey of this area was to ascertain the value of the magnetometric method in exploring for nickeliferous pyrrhotite deposits, as this deposit afforded a good opportunity of comparing the results of the magnetometric survey with those obtained from the diamond drilling. An area of about one-eighth of a square mile in extent was examined. It forms the southern part of the Frood and Stobie nickel range, an off-shoot from the main southern nickel range.

Beginning at the southwest end of the area, the rusty surface of the norite is first encountered near the boundary line between concessions V and VI, as a band indistinctly separated from the adjoining greywacke and schist. The norite rises as a ridge which is generally red-brown from the gossan, but is cut off on the surface by a narrow interruption of quartzite about 500 feet southwest of the place where the main shaft is now being sunk. The rusty norite rises again and widens greatly until, about 600 feet northeast of the new shaft, it reaches a width of about 700 feet. Quartzite and greywacke are in contact with the norite on the southeast side, while on the northwest the rocks are more varied. The rock in immediate contact is, however, generally quartzite. Beyond these rocks, which rise against each side of the norite, there are broad swamps.

Magnetometric Survey.—A base line was laid out and chained, starting from the northeast corner of the south half of lot 7, concession VI, and running for a distance of about 3,500 feet in a southwesterly direction roughly following the strike of the gabbro formation. At 25 ft. intervals, cross lines were measured, and at a distance of every 25 feet along these lines observations were taken for both the vertical and horizontal magnetic intensity by means of a Thalen-Tiberg magnetometer. By means of these observations, it was possible to trace the pyrrhotite-bearing norite formation for a distance of over half a mile. The only break in the formation indicated by the magnetic map, is where the narrow interruption of quartzite takes place. Here a break about 50 feet wide is noticed in the positive magnetic intensity. By diamond drill-hole, No. 36, it has, however, been proved that the norite formation is interrupted by quartzite to a depth of about 800 feet, but that below this level it is continuous, though a narrowing of the same very likely takes place. The area occupied by the norite formation generally shows a weak

positive magnetic attraction from 0 up to 20 degrees. Within this area are, however, numerous small singular patches showing negative attraction. Small areas with strong positive attraction are also occasionally found. These are always accompanied by strong negative areas lying side by side.

The general impression that the magnetic map seems to give is that the pyrrhotite is rather evenly disseminated throughout the whole gabbro mass, with a concentration of the mineral taking place here and there. If such a concentration takes place near the surface it undoubtedly produces the strong magnetic disturbances which are occasionally met with, while at greater depth its effect on the magnetic needle would be rather slight.

Through the courtesy of Mr. D. H. Browne, of the Canadian Copper Company, the writer was given the opportunity of comparing the results of the magnetometric survey with the records of the diamond drilling. The latter has proved that such a concentration of the pyrrhotite takes place here and there in the gabbro mass. It has also shown that this concentration of pyrrhotite does not always mean higher copper and nickel values in the ore, as in several of the areas showing a strong magnetic attraction, little or no difference has been found in the percentage of these two metals from that obtained in places where the magnetic readings are only a few degrees. The ore area blocked out by the diamond drilling coincides in this case remarkably well with that of the positive magnetic attraction, while outside of this the quartzite greywacke and diorite are situated. The depth to which the ore-body has been proved is about 1,200 feet. Down to about 400 feet the copper and nickel values are comparatively low, but below this level they average together about 4 to 5 per cent.

The conclusion arrived at in regard to the applicability of the method in exploring for copper and nickel deposits in the district may be stated as follows:—

In places where the formation is covered with swamps and drift, the approximate position of pyrrhotite deposits can be determined. It is to be remembered, however, that as it is not the pyrrhotite itself but the minerals associated with it, *i.e.*, copper pyrite and pentlandite, which make up the chief value of the ore, and as the proportion of these minerals as compared with the pyrrhotite varies considerably, the percentage of copper and nickel may be low even when a strong magnetic field is obtained.

Hence the discovery of magnetic attraction is by no means to be considered as an absolute proof of the existence of a deposit of workable ore. A steady and continuous attraction, though weak, is, however, a good indication that an ore-body may be found. Having ascertained the approximate location of a magnetic body by a magnetometric survey, diamond drilling or some other method of exploring must be used in order to ascertain the quality and character of the deposit.

INVESTIGATION OF THE CANADIAN MARKET: FOR VARIOUS MINERAL PRODUCTS IN A CRUDE OR PARTIALLY PREPARED STATE.

Howells Fréchette, M.Sc.

In the summer of 1911 an investigation was commenced for the purpose of determining what minerals are at present in use in the manufacturing industries of Canada, their source, the uses to which they are put, the degree of purity required for the various processes in which they are used, and the physical condition in which the minerals are purchased.

Before commencing the gathering of data, it was deemed best to consult with the Canadian Manufacturers' Association and explain to them the objects of the investigation, as the endorsement of that body would aid in dealing with the individual manufacturer.

After talking over the matter with Mr. W. H. Rowley, President of the Association, the following letter was sent to the Secretary:—

DEPARTMENT OF MINES,
MINES BRANCH.
OTTAWA, May 31, 1911.

To the Secretary,
Canadian Manufacturers' Association,
Traders' Bank Building, Toronto, Ont.

DEAR SIR,—Yesterday I had an interview with Mr. W. H. Rowley, regarding an investigation which is to be carried on by me for the Dominion Department of Mines.

This Department is constantly receiving inquiries for information with respect to the industrial uses for many non-metallic minerals and with respect to the market for them. Canadian manufacturing establishments import large quantities of these minerals, either in the raw or in a partially manufactured state, while the greater part of the Canadian production of these is exported. It is, therefore, evident that there should be a larger home market for non-metallic products, were information as to the trade requirements and markets more generally known. The Department has little or no information with respect to the needs of our manufacturers in this regard, and I have been instructed to visit the larger manufacturing centres in Canada to learn what mineral substances are used in the various manufacturing industries and to study the trade requirements of each industry.

It is proposed to ask the various manufacturers for information under the following headings:—

1. Class of manufactured product (such as paint, wall paper, rubber goods, electrical goods, etc.).
2. What minerals or mineral products (other than metals) are used, and for what purpose.
3. Quantities and prices.
4. If purchased as minerals, in what form? (crushed, pulverized, etc.).
5. If purchased as mineral products, what is the nature of the material, the product of what mineral or minerals, and what is the treatment through which it has passed?

6. What is the valuable constituent of the mineral? (*e.g.*, magnesite-magnesia or carbonic acid).

7. What is the percentage of purity required in each?

8. What are the deleterious impurities, and up to what percentage are they allowable?

9. Analyses.

10. Specifications used in purchasing.

11. Source of supply.

12. If foreign, why are Canadian materials not used?

13. Does the manufacturer wish to be placed on a list of consumers of the minerals used by him?

Any information supplied will be treated as absolutely confidential, where the manufacturer so desires.

It is expected that the results of this investigation will prove useful not only to the producers of minerals in Canada, but to the manufacturers also.

In carrying out this work, I am convinced that the endorsement of the investigation by the Canadian Manufacturers' Association would greatly aid me in dealing with the individual manufacturers.

Mr. Rowley advised me to write to you and ask you to be good enough to bring the matter before the Executive Council, and ask them for their endorsement.

As I expect to begin work within a week or two, your early attention will be much appreciated.

Yours very truly,

(Signed) **Howells Fréchette,**

Chief Engineer, Non-Metal Mines Division.

Reply.

Canadian Manufacturers' Association,
Toronto, June 16, 1911.

Howells Fréchette, Esq.,
Chief Engineer, Non-Metal Mines Division,
Mines Branch, Department of Mines, Ottawa.

My Dear Sir,—As promised in a previous letter, I presented your communication of May 13 to the meeting of our Executive Council held yesterday afternoon. After hearing your proposition, as outlined in your letter, the Council expressed its approval of the efforts your Department is making to secure information regarding non-metallic minerals, and it has authorized me to inform you that the members of the Association, individually and collectively, will do all they can to facilitate your work. You can inform any manufacturers whom you are circularizing in connexion with your work that your plans have the endorsation of the Council and the Association. I do not think that any of our members will refuse to answer the questions outlined in your letter, but if you should meet with any unexpected difficulties in this connexion, I shall be pleased to hear further from you, when, no doubt, we can assist you in overcoming them.

Yours faithfully,

(Signed) **H. D. Scully,**

Assistant Secretary.

Owing to the absence of a complete list of manufacturers, it was necessary to compile lists from directories and telephone books, as well as from the list published by

the Canadian Manufacturers' Association. As a result, many firms not manufacturers were included. A total of 1,313 firms were visited, and may be classified as follows:—

Manufacturers	1,097
Branches and subsidiary companies, returns of which are included in the foregoing	18
In liquidation or out of business	45
Representatives of foreign manufacturers	38
Mining companies	13
Agents, wholesale and retail dealers	102
	1,313

These 1,097 manufacturers represent over sixty industries. Of these, 357 reported that they used very little or no non-metallic minerals. The remaining 740, representing over fifty industries, use minerals.

The following list gives the minerals in use, and the number of firms reported as using each:—

Common clay	55	"Rough stuff"	1
Pipe-clay	2	"Rubbing brick"	1
China-clay	76	Rotten stone	51
Ganister	11	Hone	5
Fireclay	118	Lithograph stone	10
Slip clay	4	Yellow ochre	25
Stone clay	6	Sienna and umber	11
Sagger clay	5	Hematite	42
Ball-clay	7	Magnetite	2
Special clays	4	Pyrite	2
Quartz	18	Sulphur	46
Pebbles	1	Keystone filler	6
River and lake sand	97	Slate	15
Moulding sand	192	Slate (ground)	3
Blast sand	7	Mica schist	4
Fire sand	23	Asbestos and asbestic	52
Glass sand	6	Barytes	25
Silica sand and silex	94	Calcite	1
Limestone	32	Cryolite	2
Lime	36	Graphite	198
Marble	28	Gypsum	11
Chalk	2	Plaster of Paris	23
Whiting	44	Feldspar	18
Emery	109	Fluorspar	15
Corundum	14	Magnesite	12
Garnet	3	Mica	48
Chromitron	1	Pyrolusite	24
Pumice	140	Onyx	2
Fuller's earth	13	Phosphate rock	6
Infusorial earth	4	Salt	22
Tripoli	114	Talc	132
Blue grit	2	Witherite	1
Water stone	1	Peat litter	1

Although the data collected is not yet ready for publication, it has manifested its usefulness in furnishing information with which to reply to numerous correspondents. It may also be pointed out that while visiting the manufacturers many questions were answered regarding the availability of Canadian minerals.

This investigation will be continued during 1912, and later a full report will be published. During 1911, Mr. Fréchette was assisted by Mr. H. Bradley, B.Sc.

THE GYPSUM AND SALT INDUSTRIES OF CENTRAL AND WESTERN CANADA.

L. H. Cole, B.Sc.

The field season of 1911 was spent in central and western Canada visiting the districts in which gypsum and salt are produced, and the industries connected with the production and preparation of these minerals for market were studied in detail. Deposits of gypsum and salt are usually more or less closely associated, as a consequence of which it appeared more advantageous to carry on the two investigations concurrently.

The Gypsum Industry.

ONTARIO.

The only district in Ontario which is producing gypsum at the present time, lies along both banks of the Grand river, in the southwestern part of the Province. So far as is known, this district extends from a point about 4 miles to the southeast of the town of Cayuga, to a point about 1 mile to the northwest of the town of Paris. Although actual exposures of gypsum can be seen at only a few places along the river, the continuity of the deposits may be traced by means of the log records of the numerous gas and oil wells of that district.

The gypsum occurs interbedded with dolomite. Two or more distinct beds are being worked, the upper of which is very irregular, but yields chiefly a variety of pure, white gypsum, adapted to the manufacture of the best grades of plaster of Paris and alabastine. An analysis of material from the upper bed is as follows:—

CaO	32·70 per cent.
SO_3	46·88 "
H_2O	20·66 "
Insoluble	0·06 "
Total	100·30* per cent.

* F. G. Wait, analyst.

It is this bed that has been worked the most frequently, the first material having been taken out in the early sixties. It is never continuous for any great distance, but where found, usually holds its thickness very consistently, the interruptions occurring abruptly with very little warning. The areas of gypsum vary from 100 yards up to half a mile or more in diameter, and have an average thickness of about 4 feet.

The material of the lower of the beds at present being worked is of a greyish colour, but this bed is marked by a greater degree of continuity than the one with the whiter variety of gypsum. In many cases, drilling records indicate an entire absence of the upper bed, the first gypsum to be encountered being the grey variety. Up to the present time, this bed, where developed, has been very uniform in quality and of a thickness of about 11 feet. The gypsum is adapted to the manufacture of a fairly good variety of stucco, but, owing to its colour, cannot be used for the finer grades of plaster of Paris.

Four companies own properties in this district. Of these, two are producing steadily, while the others are just commencing operations.

The Alabastine Company of Paris.—This Company is the oldest among those actively engaged in the district, and has two mines and two mills in operation. The larger of these mines is at Caledonia, and is working in the grey gypsum. Here the rock, after passing up an incline to the top of the mill, is crushed and calcined, and the various grades of hard wall plaster prepared. A short spur line from the Grand Trunk railway to the mill affords easy shipping facilities. The second mine operated by this Company is located about 3 miles to the southeast of Caledonia, and produces white gypsum of a very pure quality. From this mine the crude material is hauled by wagon to the mill at the north of the town where it is ground and calcined. From there it is sent to Paris to the Company's second mill, where it is used in the manufacture of Church's alabastine, a wall tint that has calcined gypsum as its principal ingredient.

The Crown Gypsum Company.—This Company is working in the uppermost bed of the series. Its mine is located in Haldimand county, about 1½ miles to the southeast of the village of York. An incline driven on a slope of 1 in 10 taps the bed at a depth of 70 feet. The gypsum rock mined is a very pure and white variety, but the bed does not average more than 4 feet in thickness. The rock is taken over a narrow-gauge railway, 3 miles in length, to the Company's mill situated at Lythmore, on the Michigan Central railway. At this mill all the various grades of wall plaster and plaster of Paris are manufactured.[1]

The Toronto Plaster Company.—This Company has taken over the complete plant of the Imperial Plaster Company, consisting of a mine 2 miles southeast of Cayuga, and a small mill at Toronto. Both mine and mill were idle during the summer, but preparations are now being made to resume operations shortly.

The Caledonia Gypsum Company.—The property of this Company, on which there is a small crushing plant,[2] lies to the north of the town of Caledonia and just west of the Alabastine Company's holding. Up to the present time work has been confined to prospecting, and only a small tonnage has been crushed and shipped for use in the manufacture of cement.

MANITOBA.

The gypsum industry of this Province is each year assuming greater importance. Although deposits are known to exist in several districts, active production is confined to one locality. These deposits, which lie from 10 to 12 miles in a northwesterly direction from Lake St. Martin, are of large extent, exposures being found over an area of about 8 square miles. A branch of the Canadian Northern railway, 180 miles in length, extends north from Winnipeg to these deposits, and shipments are now being made by a continuous rail route to the mills at Winnipeg.

The gypsum lies near the surface, the overburden being seldom more than 4 feet. The surface of the country has been dissected by erosion, which has produced numerous hummocks and hollows, having a maximum relief of about 20 feet.

The gypsum bed shows stratification and the rock is fairly soft. Consequently it has been found that light charges of powder will so loosen the material that it can then be readily handled by steam shovels. The bed consists of a top covering of gypsum earth about 1 foot in thickness, underneath which the solid gypsum extends to a depth of some 60 feet.

The rock is being loaded by a steam shovel, working in a face about 20 feet in height and 30 feet in width, directly into bottom dump, steel ore cars of 40 tons capacity, which lie on a siding of the Canadian Northern railway.

[1] Since this mill was visited last June, fire has completely destroyed the plant.
[2] Since this mill was visited last June, fire has completely destroyed the plant.

An analysis of the average material shipped to the mill is as follows:—

CaO	32·60 per cent.
SO_3	44·88 "
H_2O	20·80 "
Insoluble	1·40 "
Total	99·68* per cent.

* H. A. Leverin, analyst.

This sample also contains small quantities of $CaCO_3$ and $MgCO_3$. The material shows a very faint tinge of brown.

Two companies, the Manitoba Gypsum Company and the Dominion Plaster Company, control the greater part of these northern deposits.

The Manitoba Gypsum Company.—The present output of this Company is about 250 tons a day. Its quarry, previously described, is located at Gypsumville, the northern terminus of the Canadian Northern Railway branch line from Winnipeg, while its mill is situated on the outskirts of the latter city. In treating the crude, the rock, after crushing, is subjected to a preliminary drying in a Cummer rotary calciner, which materially reduces the length of time required for subsequent treatment in the kettles.

All grades of wall plaster are produced, and these find a ready market in the western provinces. Plaster board and asbestos plaster are also being manufactured in small quantities.

The Dominion Plaster Company. The property owned by this Company lies in the northern part of the Province and is adjacent to the holdings of the Manitoba Gypsum Company. Up to the present time, operations on this property have been confined to a small amount of surface stripping in order that an estimate of the extent of the deposit could be made. No rock has as yet been shipped. A mill, situated in Winnipeg, is nearing completion, and will, when in operation, treat about 200 tons of crude rock per day.

Other Properties.—A new discovery of gypsum was made during the summer (1911) in the southern part of the Province. A syndicate of Winnipeg men, while drilling in the valley of a stream about 18 miles to the east of Dominion City, on the Canadian Pacific railway, encountered a deposit of very pure and hard, white gypsum at a depth of 325 feet. This deposit consists of a series of beds, having in all a total thickness of about 115 feet, while the maximum thickness of any single bed is about 50 feet. In view of the fact that the same series of beds has been found in each of two drill-holes, put down at a distance of more than one-fourth of a mile apart, it may be inferred that the gypsum is continuous over a considerable area. Samples taken from the drill-core were crushed and analysed with the following result:—

CaO	31·72 per cent.
SO_3	45·32 "
H_2O	20·45 "
Insoluble	2·00 "
Total	99·49* per cent.

* F. G. Wait, analyst.

The above is a very pure gypsum and should prove to be of considerable value. Small samples, which were crushed and calcined, produced a very quick-setting, strong plaster.

BRITISH COLUMBIA.

Grande Prairie Deposits.—One of the first discoveries of gypsum in the Province of British Columbia was that of a deposit situated about 11 miles east of Grande Prairie, in the southern part of the Kamloops Mining Division. This gypsum occurs on the north side of the Vernon-Kamloops wagon road, and is about 26 miles in a northwesterly direction from the town of Vernon. Two exposures, about 1½ miles distant from each other, are to be seen on the hillside on the north bank of the Salmon river. Prospecting work, which has been confined to the more easterly of these outcrops, consists of a tunnel some 40 feet long, driven in the middle of the deposit. Gypsum earth in a very finely divided state, overlies the whole surface.

At the eastern exposure the gypsum has a dip of about 80° to the north, with a strike approximately east and west. The extent of the exposure is not very great, being about 200 feet along the strike and some 300 feet north and south. Throughout its length the tunnel passes through a nearly pure and white, massive variety of gypsum. An analysis of a sample, representing the material in both sides of the drift, is as follows:—

CaO	32·60 per cent.
SO_3	46·87 "
H_2O	20·80 "
Insoluble	0·06 "
Total	100·33* per cent.

* H. A. Leverin, analyst.

The material is very uniform throughout and can be manufactured into a very high grade of plaster. The extent of the deposit has yet to be determined, since, apart from the tunnel referred to above, no prospecting has been done. The slope of the hill is about 40° and is covered sparsely with bunch grass and scattered pine trees.

The more westerly of the two exposures, outcrops along the steep side of the narrow valley, and near the summit of the northern ridge. This exposure stands out plainly as a white area among the rocks of the district. It consists on the surface of a badly disintegrated mass of gypsum rock with fragments of limestone derived by erosion from the cliffs of altered limestone overlying the gypsum. Residual pinnacles of limestone with eroded bases, remain in place in the deposit. No development work has been done and no idea of the extent of the deposit could be obtained. The material, at the surface, is badly broken and weathered. A sample taken gives the following analysis:—

CaO	31·60 per cent.
SO_3	45·61 "
H_2O	20·00 "
Insoluble	1·80 "
Total	99·01* per cent.

* H. A. Leverin, analyst.

This sample also contains $CaCO_3$ and $MgCO_3$ in small quantities. In view of the fact that extensive development work is contemplated by the owners, it is probable that in the near future a considerable tonnage of the best grades of plaster will be produced from these deposits.

Spatsum Deposits.—Two exposures of gypsum occur on the hills forming the west bank of the Thompson river, immediately opposite Spatsum, a station on the main line of the Canadian Pacific railway, 189 miles northeast of Vancouver. These outcrops are located about 2,000 feet apart. Sufficient prospecting has not been

carried on to enable one to determine whether or not these outcrops belong to the same deposit. The surface of the surrounding country is covered with alluvium, and supports a growth of bunch grass and scattered pine. The two spurs of the hill on which these outcrops occur, appear as large white masses and are visible for a long distance. At the surface, these outcrops consist of a very poor grade of gypsite or gypsum earth, mixed with altered limestone. The whole mass is badly disintegrated and streaked with stains of iron oxide. These exposures lie about 600 to 650 feet above the river, the slope of the hill being about 40°, and in some places steeper. Owing to the steep pitch, the effects of weathering have been considerable and fresh rock surfaces are hard to find.

In the more southerly of the two outcrops, a tunnel has been driven for a distance of 25 feet, and from the end of this tunnel a winze has been sunk to a depth of 30 feet. The tunnel cuts through a band of solid gypsum, having a thickness of 5 feet and a dip of about 35° to the northwest. Apart from this band, the tunnel and winze pass through highly altered broken limestone, mixed with a small amount of an inferior grade of gypsum. An analysis of the pure material, taken from the tunnel, gave the following results:—

CaO	32·70	per cent.
SO_3	46·72	"
H_2O	20·60	"
Insoluble	0·04	"
Total	100·06*	per cent.

* H. A. Leverin, analyst.

This is very nearly a theoretically pure gypsum. The material can be readily mined and sent across the river by aerial tramway to the Canadian Pacific Railway tracks. In a short time the Canadian Northern railway will be operating trains along the base of the hill in which the deposits occur.

The Industrial Finance and Development Company.—The area controlled by this Company consists of three claims, each 1,500 feet square. These claims are situated on the slope of a hill, at a distance of about one-half mile north of Merritt, a town on the Nicola branch of the Canadian Pacific railway. The timber growth on the property consists of a few scattered pine, while the surface is covered with the usual bunch grass.

The gypsum in this instance is probably due to the action of sulphur vapours and springs on the limestone which is present in considerable quantities in this district. The heated vapours become oxidized, resulting in the production of H_2SO_3 and H_2SO_4, and these react on the limestone. The final result is the formation of gypsum with the liberation of CO_2. These reactions probably take place underground, and the resultant gypsum so formed, is carried upward and deposited from the solutions as they pass over the surface. The gypsum itself occurs in a very finely divided state, and the fact that the crystals are not cemented together, not only facilitates handling, but results in the elimination of heavy crushing. Although the crude rock contains considerable vegetable matter, this fact does not appear to affect its tensile strength. It presents no difficulties as regards calcination, and forms a quick-setting, strong, and reliable plaster. On account of its colour, which is a light tinge of brown, it cannot be used for very fine or finished work where whiteness is the essential requirement; but for the manufacture of ordinary coarse stucco, it fulfils all conditions. Moreover, being admirably suited for use as a retarder in cement, and as a fertilizer for certain soils, the output should command a steady market in British Columbia.

The following analysis indicates the quality and composition of the loose material composing this deposit:—

CaO	33·80 per cent
SO_3	43·00 "
H_2O	20·60 "
Insoluble	0·50 "
Total	97·90* per cent

* H. A. Leverin, analyst.

This sample contains a little $CaCO_3$ and $MgCO_3$. The material is a gypsum earth or gypsite of a very good quality.

Very little stripping would be required in connexion with this deposit, the average depth of the overburden being about 1 foot. Owing to lack of development work, the average thickness of the bed cannot as yet be determined. Several prospect pits have shown a thickness varying from 3 to 8 feet. Complete and systematic stripping could be carried on to advantage, while a series of test pits would not only determine the depth of the deposit but would also furnish data for an estimate of the quantity of gypsum available.

The property lies within easy access of the railway, from which a spur could connect with an incline tram line from the centre of the deposits. In a mill handling this material, the preliminary heavy crushing could be dispensed with for reasons previously stated, thus allowing the product to go direct from the mine to the buhr mills.

Tulameen Deposits.—Reports of the discovery of gypsum in the Tulameen district were noted in many of the western newspapers during the spring of 1911. A deposit outcropping along the banks of Granite creek—a small tributary stream which enters the Tulameen river some 10 miles above Princeton, B.C.—has been staked by Mr. H. Churchill, of Rossland, B.C. From Mr. Churchill's description, it would appear that this is another deposit of gypsite resulting from the action of sulphur vapours on limestone. The earthy material is very similar in appearance to that of the Merritt deposit, and an analysis gave the following results:—

CaO	31·48 per cent.
SO_3	44·32 "
H_2O	22·32 "
Insoluble	n.d. "
Total	98·12* per cent.

* F. G. Wait, analyst.

Lumps of solid gypsum, pure white and greatly eroded, which were picked up in the creek bed, indicate the possible presence of this form of the mineral in place in the vicinity. No development work has as yet been done on the property.

Although the production of gypsum in Canada during 1911 showed a decrease, as compared with that of the previous year, the value of the product showed an increase of $44,417 over that of 1910. The following table shows the production of the Provinces of Ontario, Manitoba, and British Columbia, during the past five years:—

Year.	Ontario.		Manitoba.		British Columbia.	
	Quantity in tons.	Value.	Quantity in tons.	Value.	Quantity in tons.	Value.
		$		$		$
1907	10,404	52,417	.....	.....	.....	
1908	10,389	42,456	14,500	111,500	..	
1909	11,731	48,278	17,000	170,000	.....	
1910	15,055	67,229	19,500	195,000	.....	
1911	27,399	98,018	43,000	372,000	780*	1,875

* First production from this Province.

That the demand for gypsum products for building, etc., is ever on the increase, is evidenced by the heavy imports into the western provinces through the ports of entry of Vancouver, Victoria, Calgary, and Winnipeg. The large deposits of the mineral in Manitoba and in British Columbia can supply gypsum of a quality equal to any of that imported. Considering the steadily increasing demand, the next few years should witness several new properties added to the list of western producers.

The Salt Industry.

ONTARIO.

At present there is, in Canada, but one district where salt is produced. The area included in this district, lies in the southwestern peninsula of Ontario and borders on the eastern shores of Lake Huron, the St. Clair river, Lake St. Clair, and the Detroit river. The most northerly point at which salt is found is at Kincardine, and the southern limit lies below Sandwich. This area, underlain by the salt beds, may be said to approximate in shape the segment of a circle. In such a segment, Kincardine and Sandwich would constitute the northern and southern limits, while its greatest width—about 60 miles—would lie to the east of Sarnia.

The salt occurs interbedded with limestone of the Devonian age, the salt beds varying in thickness from 20 feet upwards, according to the locality.

All the salt obtained from this district is secured from the evaporation of waters which have been allowed to remain in contact with the salt beds until a saturated solution had been formed. The water employed is derived either from natural underground springs, or else is forced down through the cased drill-holes penetrating the salt beds. A second casing inside the larger one permits of the saturated brine being pumped to the surface and thence to the settling tanks. The brine produced in this district is very pure and seldom requires the addition of any chemicals to precipitate impurities. An analysis of brine taken from one of the salt wells in this district showed the following composition:—

$NaCl$	26·6415 per cent.
$CaCl_2$	0·1895 "
$MgCl_2$	0·1884 "
$CaSO_4$	0·2757 "
H_2O	72·7049 "
Total	100·0000* per cent.

* F. G. Wait, analyst.

The kettle-method of evaporation, formerly used in this district, has now entirely been replaced, either by the open-pan or by the vacuum-pan process.

Open-pan Process.—There are two open-pan systems for evaporating the water of the brines:—

(1) Where direct heat from the fires is applied underneath the pans, and

(2) Where heat is supplied to the brine by steam through pipes running along the bottom and middle of the pan, or by use of a false bottom, enabling the steam to come in contact with the whole under surface.

In the first case, the pans have a depth of about 2 feet with a breadth of 20 feet and a length of 100 feet. The brine is kept at a depth of 18 inches, and heat, from coal or wood fires in fire-boxes at one end, is applied underneath the pan. The grade of salt produced by this method of pan evaporation varies according to the intensity of the heat. Fine-grained salt is produced nearest the fires, where the evaporation is most rapid; coarser grades of salt are produced where the evaporation is slower.

The advantage of steam heat supplied through pipes lies in the fact that the grade of salt produced in any one pan is uniform, since it is possible to regulate the heat so as to keep the brine at an even temperature throughout the whole pan. These pans are called grainers and are used quite extensively in Canadian plants to obtain the coarser grades of salt.

Vacuum-pan Process.—This process is coming into use more and more as a cheap, quick, and economical method of producing the finer grades of salt. In this process a specially constructed vacuum pan is employed. The essential features of the pan consist in a series of vertical tubes arranged with their upper ends connected with a vacuum chamber. The lower ends communicate with a chamber provided with a hopper-shaped bottom. The vertical tubes are so arranged that steam for the purpose of heating can be circulated around them. Brine is introduced into the chamber below and passes up into the tubes. The pressure in the vacuum chamber is usually about one-fifth atmospheric pressure, a condition which materially lowers the boiling point of the brine, and hastens evaporation, when heat is applied. As the water evaporates, the salt in solution is precipitated and falls into the conical collecting chamber below the tubes. In some cases, heat contained in the vapour from the evaporated brine is utilized in promoting evaporation in a second pan. In this second similar pan, where the temperature is not so high, the evaporation is slower, the crystals produced are larger, and the commercial salt is of a coarser grain.

The following is a list of the Companies producing salt in the Ontario district:—

Canadian Salt Company, Windsor, Ont.
Dominion Salt Company, Sarnia, Ont.
Elarton Salt Company, Parkhill, Ont.
Exeter Salt Company, Exeter, Ont.
Gray, Young & Sparling Salt Company, Wingham, Ont.
Ontario People's Salt and Soda Company, Kincardine, Ont.
North American Chemical Company, Goderich, Ont.
Parkhill Salt Company, Parkhill, Ont.
Stapleton Salt Company, Clinton, Ont.
Western Canada Flour Mills Company, Goderich, Ont.
Western Salt Company, Mooretown, Ont.

A new plant, nearing completion, is being erected at Sandwich by the Canadian Salt Company, at which it is proposed to prepare caustic soda and bleaching powder from the salt brine. This plant will be the first of its kind to operate in Canada, and its erection marks a new departure in the industry which opens up a large field for the utilization of the excess of brine produced. The method to be employed is to decompose the brine by electrolysis into sodium hydroxide and chlorine gas. The former is purified and crystallized, while the latter is passed over lime in large, lead-lined chambers producing bleaching powder ($CaOHCl$.)

WESTERN PROVINCES.

Several of the alkali lakes in the western prairie country were visited, but owing to the excessively wet season, these lakes, which in dry years have deposits of salts anywhere up to a foot in thickness, showed only a slight saline incrustation. This prevented samples being taken and the ascertaining whether the salts were present in commercially valuable quantities.

The production of salt in Canada is showing a gradual increase each year. As is shown by the following table, this increase, which is regulated by the demand, varies greatly from year to year.

Year.	Quantity.	Value.	Increase.
	Tons.	$	%
1909	84,037	415,219	5·1
1910	84,092	409,624	0·1
1911	91,582	443,004	8·9

The percentages are calculated from the tonnage, and are based on the increase over the preceding year.

Only a very small quantity of salt is exported, the yearly average being from 150 to 250 tons.

Although the production of salt in Canada is increasing, it still supplies less than half the home consumption, the larger part being controlled by the product of the British Isles and British possessions. This salt is admitted duty free, as is also that imported from the United States for use in the fisheries.

A word might be said on the great opportunity which exists for the establishment of a soda industry. In 1909, imports of soda products in Canada were valued at $604,162, while in 1910 their value had increased to $767,846. With such unlimited deposits upon which to draw within easy access of a central distributing point for the whole of Canada, this industry should make very rapid progress. By establishing a plant at Sandwich for the production of caustic soda and bleaching powder, a start is already being made by the Canadian Salt Company, of Windsor.

ON THE PHOSPHATE AND FELDSPAR DEPOSITS OF ONTARIO AND QUEBEC.

Hugh S. de Schmid, M.E.

I was engaged during the greater part of the season of 1911 in the compilation of the monograph on mica, the field work for which was undertaken during the previous summer. A great deal of information, however, bearing on the commercial uses of the mineral and its manufacture, still remained to be collected, the work entailed thereby not being completed until the beginning of September. Having handed in my report upon the above, I at once proceeded to the Lièvre River phosphate region, in order to collect data for the monograph upon this mineral, to be issued next year by the Mines Branch. I also visited the various feldspar mines in the above district, and secured all available data regarding the occurrence, exploitation, etc., of the mineral.

STATUS OF THE PHOSPHATE INDUSTRY.

Practically all the phosphate mines in the Lièvre district have been idle since their closing down in the early nineties, this cessation of mining activity being caused by the discovery and exploitation of the enormous deposits of sedimentary phosphates in the southern United States, notably in Florida. The production of phosphate in this State commenced in 1888 with the dredging of river pebble, the output of this mineral reaching a maximum in 1893, when 122,820 tons were produced. Since 1893, the mining of hard rock phosphate and of land pebble phosphate has increased enormously, and has almost completely displaced the original industry. In 1910, the output of hard rock phosphate in Florida amounted to 438,347 long tons (a decrease of about 75,000 tons over the production of 1909), while the amount of land pebble raised reached the large total of 1,629,160 long tons—an increase of 363,000 tons over the output of the previous year. The total amount of phosphate rock raised in Florida alone in the year 1910, was thus 2,067,507 long tons. The price of hard rock phosphate averaged $6.96 per ton, and that of land pebble $3.43 per ton, f.o.b. at the mines. The hard phosphate rock has a maximum tri-basic calcium phosphate content of 85 per cent, while the average for the entire phosphate series (including sands, clays, etc.) is between 10 and 30 per cent. There were 37 companies engaged in phosphate mining in 1909 in this State, 20 operating in hard rock and 17 in land pebble.

In addition to the deposits in Florida, extensive phosphatic beds also exist in South Carolina and Tennessee, the former State in 1910 producing a total tonnage of land and river phosphate rock of 179,659, and the latter State 398,188, long tons.

In Idaho, Wyoming, Montana, Arkansas, and Utah, large deposits of phosphatic rock have been located and to some extent exploited, the total production of these States in 1910 being 10,734 long tons. Congress has, however, adopted a policy of establishing "phosphate reserves" in the last-named States; large areas have been withdrawn from public entry, and are, at the present time, awaiting the passing of some measure to govern their disposal. In Florida, also, some 37,000 acres of phosphate lands were withdrawn from entry, and the total area throughout the United States now withdrawn exceeds 2,500,000 acres.

The total phosphate production of the United States in 1910 was 2,654,988 long tons, of an average value of $4.11 per ton. These figures show an increase in tonnage of 324,836 tons over the production of 1909; the average unit value had, however, decreased $0.51.

Marketed Production of Phosphate Rock in the United States, 1900-1910, in long tons.*

Year.	Quantity.	Value.
		$
1900	1,491,216	5,359,248
1901	1,483,723	5,316,403
1902	1,490,314	4,693,444
1903	1,581,576	5,319,294
1904	1,874,428	6,580,875
1905	1,947,190	6,763,403
1906	2,080,957	8,579,437
1907	2,265,343	10,653,558
1908	2,386,138	11,399,124
1909	2,330,152	10,772,120
1910	2,654,988	10,917,000
Total	21,586,025	86,353,906

* Advance chapter from Mineral Resources of the United States, 1910.

In 1910, the exports of phosphate rock from the United States amounted to 1,083,037 long tons, valued at $8,234,276. In addition to the United States (which country, at the present time, constitutes the principal source of supply, and also the greatest reserve of natural phosphates), Algeria, Belgium, France, Tunis, and Christmas island (Straits Settlements), also produce large quantities of phosphate rock. The combined production of these five countries in 1909, amounted to 2,036,479 long tons, equal to about seven-eighths of the output of the United States for the same period.

CANADIAN PRODUCTION.

Compared with the above-mentioned large productions of foreign countries, notably the United States, the output of phosphate from Canadian deposits during recent years sinks into insignificance. In 1910, the production was 1,319 tons, valued at $11,780, giving an average of $8.93 per ton. Practically the whole of the output is consumed in this country, and is shipped to Buckingham, Que., where it is used for the manufacture of fertilizers and phosphorus. There are only two firms—the Electric Reduction Company, and the Capelton Chemical and Fertilizer Company—engaged in the manufacture of the above, and the annual demand of these for Canadian apatite, owing to the large supply of cheaper American phosphate, falls short of the thousand ton mark. The fact that the average price asked for American phosphate is only $4.11, f.o.b., while that of Canadian apatite is $8.93 (or more than double the price of the American product), naturally prohibits any extensive demand for the latter mineral; the former proves cheaper even with freight charges added. The greater quantity of the apatite marketed is derived as a by-product from the mica mines, the mica and phosphate often occurring intimately associated. Frequently, also, what was originally exploited as a phosphate mine develops into a mica mine and vice versa—the sporadic and impersistent occurrence of the two minerals being often highly perplexing to operators. At a few scattered localities mining for phosphate alone is carried on in an intermittent fashion—a few hundred tons of

mineral being produced annually. Pockets of phosphate are often encountered by mica miners, and, as the mica crystals not infrequently occur disseminated in the filling of such pockets, both minerals can, in such case, be won profitably at the same time. At most mica mines a small amount of phosphate can usually be seen, which has been saved during mining operations for the former mineral, and many of the dumps contain considerable quantities of apatite which it has not been considered worth while to save. The practice of operators is to allow the phosphate to accumulate during the summer months and to ship it away in the winter, when winter-roads afford a more direct and cheaper means of transport. Taking all factors into consideration, it can well be considered questionable whether phosphate mining in Canada can ever—even in the earliest and most profitable days of mining activity, when the mineral sold for $14 and $15 per ton—have proved a highly paying undertaking. When the so-called "phosphate boom," in the early eighties, drew attention to the extensive apatite deposits lying adjacent to the Lièvre river, Quebec, numerous companies were formed in Canada, the United States, England, and France, to exploit the ore-bodies. Large sums were subscribed, and a large amount of foreign capital was expended upon the properties, some of which employed as many as 150 to 200 men. The High Rock mine, one of the largest in the district, and situated on range VII of the township of West Portland, was equipped with a camp capable of accommodating 175 men, the buildings being laid out to form regular streets, while the machinery included thirteen boilers and two compressors. A tramway 2 miles long was built to convey the ore to the Lièvre river. The mine was first operated on a large scale about 1882, and mining was continued for some eleven years, until 1893 or 1894, when, the price of phosphate being between $7 and $8 less per ton than in 1886, consequent upon the competition of the Florida production, the mine closed down. All traces of the buildings, etc., have long since been removed or destroyed by fire, and there is little at the present day, save the extensive workings and dumps, to indicate that this mine was, some five and twenty years ago, one of the main centres of mining activity in the district. Here, as at the majority of the other dozen or so mines in the Lièvre River phosphate region, enormous bodies of high-grade (85 to 90 per cent tri-basic calcium phosphate) and almost pure apatite, containing but little mica or other mineral impurities, were met with. Despite the high grade of the ore, the high cost of extraction due to the large machinery plants installed in the majority of the mines, and also the heavy expense of transport—entailing sometimes a journey of several miles over bush roads with subsequent re-shipment at three or four points before the ore reached the consumer—combined to render the mining of the mineral an expensive and somewhat hazardous undertaking. It is said that the bottoms of many of the shafts in this district were in extensive bodies of high-grade mineral when the mines were closed down, and that the cessation of operations was due solely to the lower prices caused by foreign competition, and not to any diminution in the quantity of phosphate in sight. The year of greatest mining activity, as far as figures are available, was 1890, when the total phosphate production of Ontario and Quebec was given as 31,753 tons, valued at $361,045—an average of $11.37 per ton. The following table shows the annual output during the past twenty-five years:—

TABLE 2.

Annual Production of Phosphate in Canada 1886-1910.

Calendar Year.	Tons.	Value.	Average Value per ton.
		$	$
1886	20,495	304,338	14 85
1887	23,690	319,815	13 50
1888	22,485	242,285	10 77
1889	30,988	316,662	10 21
1890	31,753	361,045	11 37
1891	23,588	241,603	10 24
1892	11,932	157,424	13 20
1893	8,198	70,942	8 65
1894	6,861	41,166	6 00
1895	1,822	9,565	5 25
1896	570	3,420	6 00
1897	908	3,984	4 39
1898	733	3,665	5 00
1899	3,000	18,000	6 00
1900	1,415	7,105	5 02
1901	1,033	6,280	6 07
1902	856	4,953	5 79
1903	1,329	8,214	6 18
1904	817	4,590	5 62
1905	1,300	8,425	6 48
1906	850	6,375	7 50
1907	824	6,018	7 30
1908	1,596	14,794	9 26
1909	998	8,054	8 07
1910	1,478	12,578	8 51
Total	200,519	2,181,300	8 49

Several inquiries have been received recently at the Mines Branch from interested parties in Europe, relative to the opportunities for both mining and obtaining apatite in Canada. The prices offered by English consumers for the mineral ($9 to $10 per ton c.i.f. British ports) are considerably ($1.50 to $2.50) less than those being paid at Buckingham, Que.—only a few miles distant from the mines. As already remarked, few operators consider it worth while, at the present time, to extract apatite, and almost the entire demand is supplied by the mineral produced as a by-product from the mica mines.

The above remarks, referring to the conditions of the phosphate industry in the Quebec apatite district, apply equally to the mines in Ontario. The latter Province has never figured as a phosphate producer to anything like the same extent as Quebec, the largest output of apatite (based upon exports) amounting to 3,547 tons in 1889.

It seems hardly possible that, with the enormous deposits of sedimentary phosphates known to exist at many places in the world, and particularly in the neighbouring United States—deposits which can be readily and simply mined by such methods as dredging, hydraulicking, steam-shovel work, or ordinary quarrying—the apatite veins and pockets of the Laurentian series of Quebec and Ontario can ever hope to again become a profitable source of phosphate, and the objective of any extensive mining operations. The depth of the pits at the larger mines, varying from 100 to as much as 600 feet, and the present precarious state of the workings, which followed pockety bodies of phosphate having no definite shape or direction (such bodies having been robbed as far as was practicable in their entirety), would entail the expenditure of much capital, in order to put the mines into new working shape, before a ton of phosphate could be produced; while the expense of mining at such

depths would most certainly prove prohibitive, without a decided and most unlooked-for increase in the price of the mineral.

STATUS OF THE FELDSPAR INDUSTRY.

The largest production of feldspar in any one year since the inception of the industry amounts to 16,948 tons, in 1906. The output of 1910 ranks next with 15,719 tons, and the average for the past eight years (1903-1910) is 12,827 tons. Almost the entire production is, at the present time, derived from the mines in the townships of Portland and Bedford, Ont., the Kingston Feldspar and Mining Company, of Kingston, Ont., being the principal producer. This Company has been mining steadily since 1903, employs an average force of 40 to 50 men, and can produce, if necessary, as high as 100 tons of high-grade spar per diem. The entire output goes to the Pennsylvania Feldspar Company, of Charlotte, N.Y. A considerable amount of quartz is won simultaneously with the spar, and is shipped to Welland, Ont., for use in the manufacture of ferro-silicon. A number of smaller mines exist in the same district, and have been operated intermittently during the past ten years; the majority of them were, however, idle when the district was visited in October last. The spar at all the mines in this district is a terra-cotta coloured orthoclase.

A deposit of bluish-white feldspar was opened up in 1911, by Mr. E. Smith, on lot 13, concession V, of the township of North Burgess, Ont. The rock partakes of the nature of a very coarse graphic granite, and the spar is said to be of good quality. The owner reports an output of 700 tons, shipped to Trenton, New Jersey.

On Bobs lake, in the township of Bedford, the Suroff Feldspar Mining and Milling Company are erecting a camp and plant, and propose commencing operations, both mining and grinding, in the near future.

In the Parry Sound district, on lot 4, concession IX, of the township of Conger, the Ojaipee Silica and Feldspar Company have carried out a little work for both feldspar and quartz, the latter being the preponderating mineral.

The production of feldspar in the Province of Quebec is practically limited to a small output of high-grade, white spar (microcline) used in dentistry, which brings as high as $35 to $40 per ton. This spar is derived from the Villeneuve mine, in the township of Villeneuve, about 25 miles north of Ottawa, and is won simultaneously with the mica for which the mine is operated. The latter mineral is no longer found in paying quantities, and the mine was shut down in September, 1911. Small deposits of similar spar, mixed more or less intimately with the other varieties of the mineral, known as orthoclase and albite, exist at several spots in the area immediately to the north of Ottawa. Such deposits (pegmatite dykes) have been worked intermittently during the past five-and-twenty years, either for spar alone, or for the mica which they contain, the spar being saved as a by-product. With the exception of a small deposit on lot 22, range VI, of the township of West Portland, opened in September last by Messrs. O'Brien and Fowler, for mica and spar, none of the feldspar properties in this region are at present being operated.

On the north shore of the St. Lawrence, at Quetachu-Manikuagan bay, an extensive deposit of good quality, white feldspar is reported by J. Obalski.[1] No work appears to have been carried out here since 1899, when a couple of hundred tons of spar were produced.

Outside of Ontario and Quebec, no economic deposits of feldspar appear to have been located in the Dominion, and the supply of the mineral is derived entirely from the above-mentioned mines.

The following table shows the production of feldspar in Canada from 1890 to 1910:—

[1] Ann. Rep. Dept. Mines, Prov. Que., 1899.

Annual Production of Feldspar in Canada, 1890-1910.

Calendar Year.	Tons.	Value.	Calendar Year.	Tons.	Value.
		$			$
1890	700	3,500	1901	5,350	10,700
1891	685	3,425	1902	7,576	15,152
1892	175	525	1903	13,928	18,966
1893	575	4,525	1904	11,083	22,166
1894	Nil.	Nil.	1905	11,700	23,400
1895	....	*2,545	1906	16,948	40,890
1896	972	*2,583	1907	12,584	29,819
1897	1,400	3,290	1908	7,877	21,099
1898	2,500	6,250	1909	12,783	40,383
1899	3,000	6,000	1910	15,809	47,667
1900	318	1,112			

* Exports.

As is evident from this and the following table, the demand for feldspar by consumers in the United States has shown little variation during recent years, and operators have not been led to materially increase their output. In the United States, the spar employed is mainly derived from pegmatite, or coarse granitic dykes, and is not nearly so pure as that from the Canadian mines and especially from those in the Kingston district, the product of the last-named mines being always certain of finding a ready market at the Ohio and New Jersey potteries. The price paid by United States consumers for the highest grade, or "No. 1 Canadian," is between $5 and $5.50 per long ton f.o.b. mills, while the output of the Maine, Connecticut, and Maryland quarries brings from $2.50 to $4.50 per long ton, the average price being about $4. A duty of 20 per cent ad valorem is imposed by the United States upon ground feldspar entering that country, while the crude mineral enters free.

Production of Feldspar in the United States, 1906-1910, in short tons.*

Year.	Crude.		Ground.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$
1906	39,976	132,643	32,680	268,888	72,656	401,531
1907	31,080	101,816	60,719	457,128	91,799	558,944
1908	18,840	65,780	51,634	362,773	70,474	428,553
1909	25,506	70,210	51,033	354,392	76,539	424,602
1910	24,655	81,965	56,447	420,487	81,102	502,452

* Advance Chapter from Mineral Resources of the United States, 1910.

I.

THE DETERMINATION OF MOISTURE IN FUELS.

Edgar Stansfield, M.Sc.

Introduction.—In November, 1910, the writer, with the permission of Dr. Haanel, became a member of the sub-committee (of the Commission Internationale d'Analyses, connected with the Eighth International Congress of Applied Chemistry, New York, 1912) on "The Standardization of Methods of Determining Water in Coal and other Fuels and in Minerals." In the autumn of 1911, the chairman of the sub-committee, G. T. Holloway, of London, England, sent out identical specimens of six coals to a number of the members of the Committee with a request that they should determine the water in them by three or more different methods.

The following is the report of the work done and the suggestions made by the writer. The full report of the Committee, which will embody the results and recommendations of all its members both with regard to water in fuels and in minerals, will be presented to the International Congress of Applied Chemistry at its meeting in New York in September, 1912.

All the following tests, with the exception of those on peat, were made on the six samples of coal supplied for the purpose. The subject was considered from the point of view of a commercial laboratory, that is, methods were considered by which a number of samples could be treated at once and the errors inherent in such methods were investigated. No efforts were made to get a succession of concordant results (regardless of their actual accuracy) and methods that could only be applied to single samples under research conditions were not considered. The tests made are obviously far from complete, but it was hoped that they would supplement work done by other members of the Committee.

It is worthy of note that in Canada when this work was done, the relative humidity indoors is generally extremely low during the winter months, although in the summer it is very high.

Apparatus Employed.—The customary laboratory equipment was employed, except for the two drying ovens used, which were as follows:—

(1) An electric oven made by the International Instrument Company, of Cambridge, Mass., U.S.A. This oven is 12″ × 12″ × 12″ inside; air passes over electrically-heated coils below the oven, enters through holes in the walls and escapes through a vent in the top. A mercury thermostat regulator controls the resistance in the heating circuit and keeps the temperature of the oven constant within about 2° C., although the temperature is not uniform throughout the interior. It was found that when the oven thermometer, which was in a corner at the back with its bulb on a level with the middle shelf, registered 105° C., a thermometer with its bulb standing in a crucible of coal at the front of the bottom shelf registered 109° C., and one with its bulb in a crucible of coal at the front of the middle shelf registered 103° C. With one exception, duly noted, all coals dried in this oven were placed about the middle of the middle shelf where the temperature would average close to 104° C.

(2) A toluol oven described by R. L. Sian (Journ. Soc. Chem. Indust., Vol. XXX, No. 2, Jan. 31, 1911, p. 61) and made by Baird & Tatlock, of London. This oven is 12″ long by 2⅝″ wide by 1½″ high inside. The door is made airtight with

a rubber gasket, and the oven is arranged so that a current of gas, which is heated to the oven temperature by the toluol vapour before it enters the drying chamber, can be passed through. Experiments showed that, neglecting the extreme ends of the oven, the inside temperature was very steady at from 108°-109° C. Coals were put into this oven when it was cold and it usually took about ten minutes to reach full heat throughout; five minutes extra time was allowed in all experiments to compensate for this delay in heating. The air or gas passed through the oven was previously dried by means of a U tube filled with calcium chloride and a wash bottle of sulphuric acid. Nitrogen, and carbondioxide were first freed from traces of oxygen by passing them through a pipette filled with sticks of yellow phosphorus. The volume of the gas was measured by a meter after it left the oven.

Experimental.—The experiments made can be divided into two series; series I was begun on January 26, 1912, and series II on February 7.

In series I, a number of sample tubes, weighing bottles, etc., were first prepared and labelled; then one of the cans containing the coal samples was opened, for the first time, the contents thoroughly mixed with a spatula, and two sample tubes, 3″ × ½″ outside, were filled with the coal and at once corked. Ten other sample tubes 2″ × ½″ were similarly filled. Another portion of the sample was put into a special glass tube which was at once sealed in a blowpipe flame; and about a gram of the coal was introduced into a small weighing bottle, 2″ × 1″, that had been weighed empty a few minutes before. Four or five briquettes of the coal were made in a briquetting press and put into another small weighing bottle (this being omitted in the case of coal No. 1), and the sample can carefully closed again. The whole operation was completed in from ten to fifteen minutes, after which the 2″ × 1″ weighing bottle was at once reweighed. The relative humidity in the laboratory at the time was about 24 per cent. All six cans of coal were similarly treated, after which the six weighing bottles were placed unstoppered in a desiccator, containing about 125 c.c. of concentrated sulphuric acid. The desiccator was then exhausted by means of a water pump to a pressure of about 60 mm. of mercury.

The sample tubes employed were closed with corks that had been impregnated with paraffin wax; and were then stored until used, in large weighing bottles or in corked containers. When a test was to be made, a tube was weighed corked, about a gram of the coal poured out into a crucible, and the tube at once recorked and reweighed. The difference of weight gave the exact weight of coal taken. This method renders it possible to carefully weigh out a portion of coal without risk of its gaining or loosing moisture during the process; it is not possible, however, in this way to take an exact gram of the sample.

Series II.—Some of the results obtained in the experiments of series I could only be accounted for by the supposition that the moisture content of the sample tubes had changed before use. On February 7, the original sample cans were again opened, the contents well mixed, and from each sample about one gram of coal was put into each of six 2″ × ½″ sample tubes and into a weighed 2″ × 1″ weighing bottle, and all these were at once carefully weighed. The weighing bottles were placed over strong sulphuric acid in a desiccator which was exhausted to 60 mm. as before, and the six tubes of each sample were stored together in a large weighing bottle until used. These sample tubes were reweighed before use. The change in weight has been reported in each case, but all results have been corrected to the weight of coal in the tube immediately after filling. In order to be able to make the necessary calculations the entire contents of a tube had to be taken if this had changed in weight; and thus in series II, although the tubes were not completely filled, considerably more than one gram of coal was frequently taken; the use of smaller tubes would have been much better.

In both series, when an exhausted desiccator was to be opened, air was first allowed to pass in through a sulphuric acid wash bottle. The bottles were then stoppered, and allowed to stand for a few minutes in the balance case before they were weighed; two small vessels containing sulphuric acid being always kept in the balance case. The crucibles containing coal were cooled after heating in desiccators over strong sulphuric acid. Only two crucibles were placed in each desiccator, and they were weighed as soon as cool. Weighings were made as quickly as possible, and the crucible was covered during the process by a counterpoised watch glass.

The details of the separate experiments are as follows, the results are given in tabular form later.

Series I, Experiment 1.—Weighing bottles filled directly from the main coal sample on January 26, dried in exhausted desiccator over sulphuric acid, and reweighed every two or three days up to twelve days.

Experiment 2.—Coals dried for 1 hour in 25 c.c. porcelain crucibles on the bottom shelf of the electric oven; the temperature was not well regulated on this occasion, and would probably average about 110°-112° C. in the crucibles.

Experiment 3.—Coals dried for 1 hour in 15 c.c. porcelain crucibles on the middle shelf of the electric oven.

Experiment 4.—Like 3, except that 25 c.c. crucibles were used.

Experiment 5.—Coals dried for 1 hour in 20 c.c. porcelain capsules in toluol oven; 24 litres of dry air being meanwhile drawn through the oven.

Experiment 6.—Coals dried for 1 hour in 20 c.c. capsules in toluol oven; 66 litres of dry air being meanwhile drawn through.

Experiment 7.—Coals were dried in 25 c.c. porcelain crucibles over sulphuric acid in exhausted desiccator and weighed at intervals during a period of 9 days. The crucibles were then heated for 1 hour in the toluol oven in a stream of dry, purified carbon dioxide; 5 litres being passed through to displace the air before the oven was heated, and 11 litres afterwards. The crucibles were then cooled and weighed. Finally the crucibles were heated in the toluol oven for one hour, during which time 17 litres of dry air were drawn through.

If it is assumed that the nine days drying in the exhausted desiccator had completely removed the moisture from the coal, and that carbon dioxide is a neutral gas, then the change in weight during the first hour's heating was due to loss of volatile matter other than moisture, and during the second hour's heating to the oxidation of the coal—two changes which ordinarily go on together when coal is heated in air.

Experiment 8.—Coals were dried for 2 hours in 20 c.c. capsules in toluol oven, 73 litres of dry air being meanwhile drawn through.

Experiment 9.—Coals were dried for 2 hours in 15 c.c. crucibles in electric oven.

Experiment 10.—Coals were dried for 1 hour in 20 c.c. capsules in toluol oven; the air was displaced by dry, oxygen free, nitrogen before the oven was heated, and 25 litres of the same gas were passed through afterwards.

Experiment 11.—Coals were dried for 1 hour in 20 c.c. capsules in toluol oven in a stream of dry, oxygen free, carbon dioxide; 5 litres were passed through before the oven was heated and 17 litres afterwards.

Experiment 12.—Coals were dried for 2 hours in 20 c.c. capsules in toluol oven in a stream of dry, oxygen free, nitrogen; 5 litres being passed through before the oven was heated and 38 litres afterwards. After the capsules had been weighed, as usual, they were reheated for 1 hour as before, except that 39 litres of dry air were now drawn through.

Series II. Experiment 13.—Weighing bottles were filled directly from the main coal samples on February 7, dried in an exhausted desiccator over sulphuric acid, and reweighed every 2 or 3 days up to date.

Experiment 14.—Coals were dried for 1 hour in 15 c.c. crucibles in electric oven, cooled and weighed as usual, and then heated for a second hour under the same conditions.

Experiment 15.—Coals were dried for 1 hour in 20 c.c. capsules in the toluol oven in a stream of purified carbon dioxide; 5 litres were passed through before the oven was heated and 17 litres afterwards. The capsules were then cooled and weighed as usual. The heating, etc., was repeated for a second hour as before, except that 5 and 15 litres of carbon dioxide were passed through before and during the heating, respectively. Finally a third hour's heating was given, during which 34 litres of dry air were drawn through.

Experiment 16.—Coals were dried for 1 hour in 20 c.c. capsules in the toluol oven, a stream of 36 litres of dry air being drawn through. After cooling and weighing a second hour's heating was given, during which 21 litres of dry air were drawn through.

Experiment 17.—Coals were dried for 2 hours in 15 c.c. crucibles in electric oven.

Experiment 18.—Two tubes of each sample left over from those filled on February 7, were reweighed on February 14 and February 17.

Description of Coal Samples.

The description of the coal samples supplied by the Chairman of the Committee is briefly as follows: the figures are extremely rough and were merely given by him as an indication of the type of coal.

SAMPLE NUMBER.

	1.	2.	3.	4.	5.	6.
	%	%	%	%	%	%
Moisture	2	8	6	5	6	8
Total volatile matter, excluding water.	5	35	34	*23	33	27
Ash	8	3½	4½	37	8½	10

* Excluding sulphur.

No. 1 is an anthracite from South Wales.

No. 2 is from the "10 yard" or "thick coal" seam of South Staffordshire (England) and in many respects resembles a lignite.

No. 3 is from the Kilburn seam of Leicestershire (England) and is a coking coal.

No. 4 is a coal from South America; it is interesting in connexion with moisture determination on account of its high sulphur content (4·2% volatile, 8·2% non-volatile). No pyrites is visible or can be washed out, but the coal rapidly weathers and develops free sulphuric acid and ferrous sulphate.

No. 5 is ordinary bituminous coal from Leicestershire.

No. 6 is a somewhat less bituminous coal from the southeast of Scotland.

SERIES I AND II.

Coals dried in weighing bottles in Exhausted Desiccator.

Total percentage loss of weight of coals after successive periods of drying.

Time elapsed.			2 days.	3 days.	5 days.	7 days.	10 days.	12 days.	13 days.	54 days.
Coal.	Experiment.	Weight of coal.								
1	1	1·1227	...	3·03	3·08	3·08	3·10	3·08	....	
	13	1·1292	3·04	......	3·09	3·13	3·08	.....	3·09	3·14
2	1	1·1752	.....	9·78	10·03	10·10	10·17	10·17	....	
	13	0·9940	9·97	...	10·08	10·13	10·16	......	10·26	10·45
3	1	1·3791	....	7·40	7·61	7·69	7·76	7·75	...	
	13	1·3973	7·47	....	7·56	7·61	7·65	.....	7·74	7·87
4	1	1·3939	...	5·02	5·34	5·47	5·57	5·60	..	
	13	1·2877	5·12	..	5·29	5·37	5·45	.....	5.66	6·31
5	1	1·0179	...	7·27	7·46	7·58	7·59	7·59	...	
	13	0·7858	7·34	..	7·46	7·48	7·51	...	7·60	7·74
6	1	1·1906	....	7·68	7·83	7·93	7·93	7·92	...	
	13	1·0202	7·72	..	7·80	7·81	7·83	....	7·89	7·98
Average	1	1·21	...	6·70	6·89	6·98	7·02	7·02	.....	
	13	1·10	6·78	....	6·88	6·92	6·95	....	7·04	7·25

Samples taken from main supply on January 26, and February 7, respectively.

SERIES I.

Experiment 7.—Coals dried 9 Days in Desiccator then heated 1 hour in Carbon Dioxide and 1 hour in Air.

—	Weight of coal taken from tubes on Jan. 31.	Loss of weight after 1 day's drying.	Total loss of weight after 2 day's drying.	Total loss of weight after 5 day's drying.	Total loss of weight after 9 day's drying.	After heating for 1 hour in toluol oven in an atmosphere of carbon dioxide.		After further heating for 1 hour in toluol oven in an atmosphere of air.	
						Change of weight caused.	Total net loss of weight.	Change of weight caused.	Total net loss of weight.
Coal.	grams.	%	%	%	%	%	%	%	%
1	1·2833	2·69	2·81	2·87	2·87	+0·01	2·86	−0·02	2·88
2	1·0696	9·70	9·94	....	....	....	....	....	
3	1·2474	7·26	7·49	7·65	7·70	−0·05	7·75	+0·18	7·57
4	1·3706	5·14	5·45	5·84	5·99	−0·30	6·29	+0·02	6·27
5	1·0271	7·09	7·41	7·49	7·58	−0·09	7·67	+0·19	7·48
6	1·2772	7·44	7·65	7·77	7·81	−0·06	7·87	+0·21	7·66
Average	1·21	6·55	6·79	....	....	0·10	....	+0·12	

Interval changes as well as total changes expressed as percentages of original weight of sample.

SERIES I.

Coals dried in Electric Oven.

Percentage loss of weight of coals.

Number of experiment	2	3	4	9
Date of experiment	Jan. 27.	Jan. 29.	Jan. 29.	Feb. 3.
Time of heating	1 hour.*	1 hour.	1 hour.	2 hours.
Coal.	%	%	%	%
1	3·15	2·83	2·83	2·79
2	10·18	9·92	9·98	9·85
3	7·69	7·33	7·32	7·24
4	6·26	6·00	6·03	6·01
5	?	7·44	7·44	7·28
6	7·65	7·57	7·47	7·19
Average	—	6·85	6·85	6·73

* Coals heated on bottom shelf of oven.

SERIES I.

Coals dried in Toluol Oven.

Number of experiment....	5	6	8	10	11	12		
Date of experiment........	Jan. 30.	Jan. 31	Feb. 1.	Feb. 3.	Feb. 5.	Feb. 6.		
Time of heating.	1 hour.	1 hour.	2 hours.	1 hour.	1 hour.	2 hours	1 hour.	
Gas in oven	air.	air.	air.	nitrogen	carbon dioxide.	nitrogen	air.	
Litres of gas passed through.	24	66	73	25	17	38	39	
	Loss of weight.	Loss of weight.	Loss of weight.	Loss of weight.	Loss of weight.	Loss of weight.	Change of weight*	Total net loss of weight.
Coal.	%	%	%	%	%	%	%	%
1	2·97	2·82	2·79	2·70	2·76	2·40	+0·05	2·35
2........	9·77	9·96	9·59	10·01	9·69	10·26	+0·19	10·07
3........	7·31	7·55	7·08	7·53	7·49	7·65	+0·15	7·50
4	6·01	6·05	5·95	6·30	5·87	6·21	+0·03	6·18
5........	7·15	7·49	7·02	7·64	7·07	7·23	+0·09	7·14
6........	7·71	7·64	7·31	7·64	7·27	7·19	+0·11	7·08
Average........	6·82	6·92	6·62	6·97	6·69	6·82	+0·10	6·72

* Expressed as percentage of original weight.

TABLE 5—SERIES II.

Coals dried in Electric Oven.

Number of experiment........	14					17.		
Date of experiment	February 8.					February 12.		
Time of heating	1 hour.			1 hour.		2 hours.		
—	Weight of coal taken from tubes.	Change of weight of coal in tube before use.	Total net loss of weight after first heating.	Change in weight caused by second heating.	Total net loss of weight after second heating.	Weight of coal taken from tubes.	Change of weight of coal in tube before use.	Total net loss of weight after heating.
Coal.	grams.	%	%	%	%	grams.	%	%
1	1·0907	+0·03	3·01	+0·06	2·95	1·1172	+0·01	2·82
2	1·3038	−0·02	10·08	....	......	1·4034	+0·05	9·78
3	1·3140	−0·02	7·54	+0·05	7·49	1·3594	−0·13	7·30
4	1·5981	−0·02	5·98	−0·04	6·02	1·3524	+0·06	5·93
5	1·1663	−0·02	7·33	−0·09	7·42	1·2566	−0·02	7·26
6	1·2746	+0·02	7·44	−0·08	7·52	1·2167	+0·02	7·53
Average	1·29	−0·01	6·90	−0·02	......	1·28	0·00	6·77

All changes of weight calculated as percentage of original weight of coal as filled into tubes on Feb.

SERIES II

Coals dried in Toluol Oven.

No. of experiment..	15.							16.				
Date of experiment..	Feb. 8.			Feb. 9.		Feb. 10.		Feb. 12.				
Time of heating.....	1 hour.			1 hour.		1 hour.		1 hour.			1 hour.	
Gas in oven . .	Carbon dioxide			Carbon dioxide		Air.		Air.			Air.	
Gas passed through.	17 Litres.			15 Litres.		34 Litres.		36 Litres.			21 Litres.	
—	Weight of coal taken from tubes.	Change of weight of coal in tube before use.	Total net loss of weight of coal at end of first heating.	Change of weight caused by second heating.	Total net loss of weight of coal at end of second heating.	Change of weight caused by third heating.	Total net loss of weight of coal at end of third heating.	Weight of coal taken from tubes.	Change of weight of coal in tube before use.	Total net loss of weight of coal at end of first heating.	Change of weight caused by second heating.	Total net loss of weight of coal at end of second heating.
Coal.	grams	%	%	%	%	%	%	grams	%	%	%	%
1..................	1·2439	−0·01	3·02	−0·06	3·08	+0·05	3·03	1·4049	−0·02	3·06	−0·09	3·15
2..................	1·2665	0·00	10·28	−0·08	10·36	+0·16	10·20	1·4041	−0·01	10·13	+0·04	10·09
3..................	1·1823	−0·01	7·84	−0·05	7·89	+0·16	7·73	1·4488	−0·19	7·47	+0·07	7·40
4..................	1·6490	0·00	6·19	−0·13	6·32	0·00	6·32	1·6342	−0·04	6·08	−0·03	6·11
5..................	1·0577	+0·03	7·61	....	..	+0·10	.....	0·9998	−0·69	7·35	+0·07	7·28
6..................	1·1942	−0·07	7·83	+0·01	7·82	+0·13	7·69	1·2440	+0·02	7·55	+0·11	7·44
Average	1·27	−0·01	7·13	−0·06	...	+0·10	...	1·36	−0·16	6·94	+0·03	6·91

SERIES II.

Change in Weight of Tubes filled February 6.

Mark on tube.	F.	E.	D.	C.	B.				A.			
Days elapsed between filling and re weighing tube.	1	1	5	5.	7.	10.	13.	54.	7.	10.	13.	54.
Coal.	grams.	grams.	grams.	grams.	grams.	grams.	grams.	grams.	grams.	grams.	grams.	grams.
1	0·0003	0·0001	0·0003	+0·0001	+0·0002	−0·0001	−0·0003	+0·0044	−0·0001	−0·0005	−0·0008	0·0047
2.	0·0003	0·0000	0·0002	+0·0007	+0·0011	−0·0012	+0·0012	−0·0025	−0·0041	−0·0059	−0·0076	0·0244
3.	0·0003	0·0001	−0·0028	0·0018	0·0004	+0·0003	−0·0002	−0·0043	+0·0003	−0·0001	−0·0006	0·0054
4.	0·0003	0·0000	0·0006	+0·0008	0·0005	0·0005	−0·0008	0·0044	0·0008	+0·0012	+0·0013	0·0010
5	0·0002	+0·0005	0·0069	0·0002	+0·0008	+0·0008	+0·0005	0·0022	+0·0015	+0·0005	−0·0002	0·0076
6...	+0·0002	0·0008	+00·002	0·0002	0·0008	0·0011	−0·0020	−0·0092	0·0000	−0·0002	−0·0008	0·0062

Average weight of coal in tubes emptied was 1·30 grams.

CONCLUSIONS AND SUGGESTIONS.

Air Drying of Coal.—The method used by the writer in the past, and which has given him satisfaction, consists in exposing coal, crushed to ¼", in shallow trays in an air-tight box in which are also a number of trays containing calcium chloride solution of 1·30 specific gravity.[1] Under these conditions nearly all wet coals, with the exception of lignites, lose moisture for about a week, after which they begin to slowly gain in weight owing to absorption of oxygen. The trays are weighed every day or two until an increase in weight is noticed, and the maximum loss of weight is taken as the moisture lost on air drying. The coal is then ground in a ball mill, and the moisture found in the ground coal reported as the moisture in air dry coal. Other analyses of the coal were made on a separate sample, and not on the coal exposed to oxidation by the air drying process. A slow current of air, bubbled through the calcium chloride solution and then circulated through the drying chamber, would doubtless accelerate the drying. The above solution will moisten, or dry, air to about 60 per cent humidity.

Grinding of Coal Samples.—The writer heartily endorses the recommendation that a ball mill should be employed.

Storage of Sample before Analyses.—The problem is to find a method of storing samples, such that not only can the moisture in the sample as prepared be accurately determined, but that successive portions can be taken for other analyses that shall contain the same moisture as the portion in which moisture has already been determined. If small sample tubes, such as were employed in these experiments, preserved their contents unchanged, a number of tubes filled with the original sample would satisfy the conditions of storage as outlined above. The experiments made, however, were very disappointing and some of the results are distinctly puzzling. It is at first sight hard to see how, with similar tubes containing samples of the same coal, and kept in the same container at the same time, some can gain in weight while others lose. It should, however, be considered that air contains about 23 per cent by weight of oxygen, but that, even if it enters the tubes only one-fourth saturated and leaves saturated with water vapour at 20° C., it can only remove about 1 per cent of its weight of water. If then, the diffusion of air through a cork is extremely slow, the absorption of oxygen by the coal in the tube may easily be twenty times as great as the loss of moisture. On the other hand, where, owing to the use of an inferior cork, the diffusion of air is more rapid, the moisture loss may become serious and yet the coal be unable to absorb oxygen, little, if any, more rapidly than it did before, in spite of the great increase in the supply of that gas. Although the use of rubber stoppers for the tubes might largely obviate the above difficulty, the only really safe method would appear to consist in filling a sufficient number of small glass tubes with the sample as soon as it is prepared, and to seal them off in a blowpipe flame, a separate tube being used for each determination made. When its contents were required for use, the end would be cut off a tube, a glass cap slipped over the open end, the tube and cap weighed, a suitable amount of coal poured out in a crucible or other vessel, and the tube reweighed with its cap on. If only a few determinations are to be made, and if these can be begun at once, the difficulty is not serious. But where complete proximate and ultimate analyses, and determinations of calorific value have to be made, possibly on several samples at once, delay is inevitable in all but large laboratories, and precautions against change must be taken. The percentage change in a comparatively large sample in a bottle might not be so large over a certain period as in the small samples in tubes. If, however, as is stated by N. W.

[1] "An investigation of the Coals of Canada," Report 83, Mines Branch, Department of Mines, Canada, Vol. II, p. 130.

Lord (United States Geol. Survey, Prof. Paper 48, p. 192), since the heavier particles tend to accumulate towards the bottom of the bottle, it is necessary to turn the whole of the contents of a bottle out on a sheet of paper and to mix it up well every time a portion is taken for analysis, the difference in moisture content between the first and last portions taken for analysis may easily be quite considerable. Furthermore, the method in which one gram of a coal sample is weighed out in a counterpoised scoop, is often very unsatisfactory on account of obvious gain or loss of weight of the sample during the operation.

Determination of Moisture.—Drying the sample over sulphuric acid in an exhausted desiccator appears to be the best method, but this is very slow for ordinary use. Some samples may be completely desiccated in 24 hours, especially if only one sample is put into a desiccator and if the coal is exposed in a very thin layer; for such a purpose a very low, wide weighing bottle might be made. Ten days appeared the minimum time necessary in the above experiments,[1] and the coals differed markedly in their rate of drying. Coal No. 4 was notably slow, but that is not a normal coal and hardly needs to be considered. If this method is adopted, a minimum limit should be set as the permissible strength of sulphuric acid used. It is obviously impossible to use fresh acid for every determination, but how frequently ought it to be renewed?

Hot drying is far quicker than the above, but two notable errors are introduced, the first being the loss of volatile matter other than moisture, and the second the oxidation of the coal. The writer intended to thoroughly investigate these two points, but was hardly able to do more than make a beginning. The tables given indicate that these errors are not negligible. They may sometimes largely neutralize each other, since most, if not all, coals first gain in weight by oxidation under these conditions, but it is not safe to assume that they will always do so. One solution of the difficulty is to determine the moisture directly by collecting and weighing it, instead of indirectly from the loss in weight of the coal; this is rather a difficult operation and each sample would have to be treated separately. Oxidation can be avoided by heating the coal in a neutral gas such as nitrogen, but this is a troublesome operation as nitrogen cannot be easily prepared on a large scale in the laboratory. Carbon dioxide can be more readily prepared, or may be obtained in cylinders; it is probably a satisfactory substitute for nitrogen, although E. Richters has stated in a paper (Dingler's Poly. Journ., Vol. 195, 1870, p. 315) that coal absorbs carbon dioxide with the greatest readiness at ordinary temperatures.

A method might be devised which would combine the advantages of the vacuum and the heating methods, without the more serious disadvantages of either. A double chamber desiccator could be constructed, in one chamber of which the coal sample or samples would be heated by means of an electric heater or a current of hot water to a definite temperature, which need not be as high as 100° C., and in the other chamber the usual sulphuric acid could be kept cool. If this desiccator was suitably designed so as to permit of free air circulation between the two chambers, it would, when well exhausted, probably thoroughly dry coal samples in a few hours without notable oxidation. Reduced pressure would, of course, increase the tendency for volatile matter to be given off. Whether this would be a serious matter or not could only be settled by experiment.

The writer has had no experience with the calcium carbide method for the determination of moisture.

Reporting of Results.—After a consideration of the above results and discussion, it is hardly necessary to emphasize the absurdity of reporting coal analyses to the

[1] Experiment 13 was carried on for a further period of 41 days after this report was written, the results, which are included in Table I, show that a marked loss in weight takes place even after 13 days drying.

hundredth of one per cent. Sulphur, nitrogen, and possibly hydrogen are the only constituents commonly determined in which the second decimal figure is at all reliable, and, quite apart from accuracy, it is only for the hydrogen that this second figure has any practical value. The writer hopes that the Committee will see fit to discourage the reporting of a second decimal figure for the results of any determinations except those of hydrogen, and in special research work where small differences are being looked for.

NOTE ON THE DRYING OF PEAT.

When a tray of crushed peat is dried in an oven at 105° C. until no further loss of weight occurs, it is generally easy to determine when the peat is dry by the characteristic odour which it gives out and which pervades the whole room. This smell is probably due to hydrocarbons evolved, and the question arose as to whether the peat was materially altered by drying. A number of experiments on this point have shown that at any rate, within the limits of experimental errors, the calorific value of the peat was not changed by such treatment.

The following series of experiments will show the character of the results obtained: a single damp peat briquette, made at the Government Peat Bog, Alfred, Ontario, was taken and a number of cuts were made through it with a saw. The sawdust was screened and all that passed through a 20-mesh screen was taken for the experiments. Three portions were taken from this sample—one was dried in the oven, a second was dried in a desiccator, and the third was briquetted for calorimeter determinations. Sixty-one small briquettes were made, weighing 7·87 grams altogether.

(*a*) Sample dried at 110° C.:—

9·3 g. taken, heated for 4 hours,		loss	= 41·0	per cent.
" " 9 "	total	"	= 41·14	"
" " 13 "	"	"	= 41·23	"

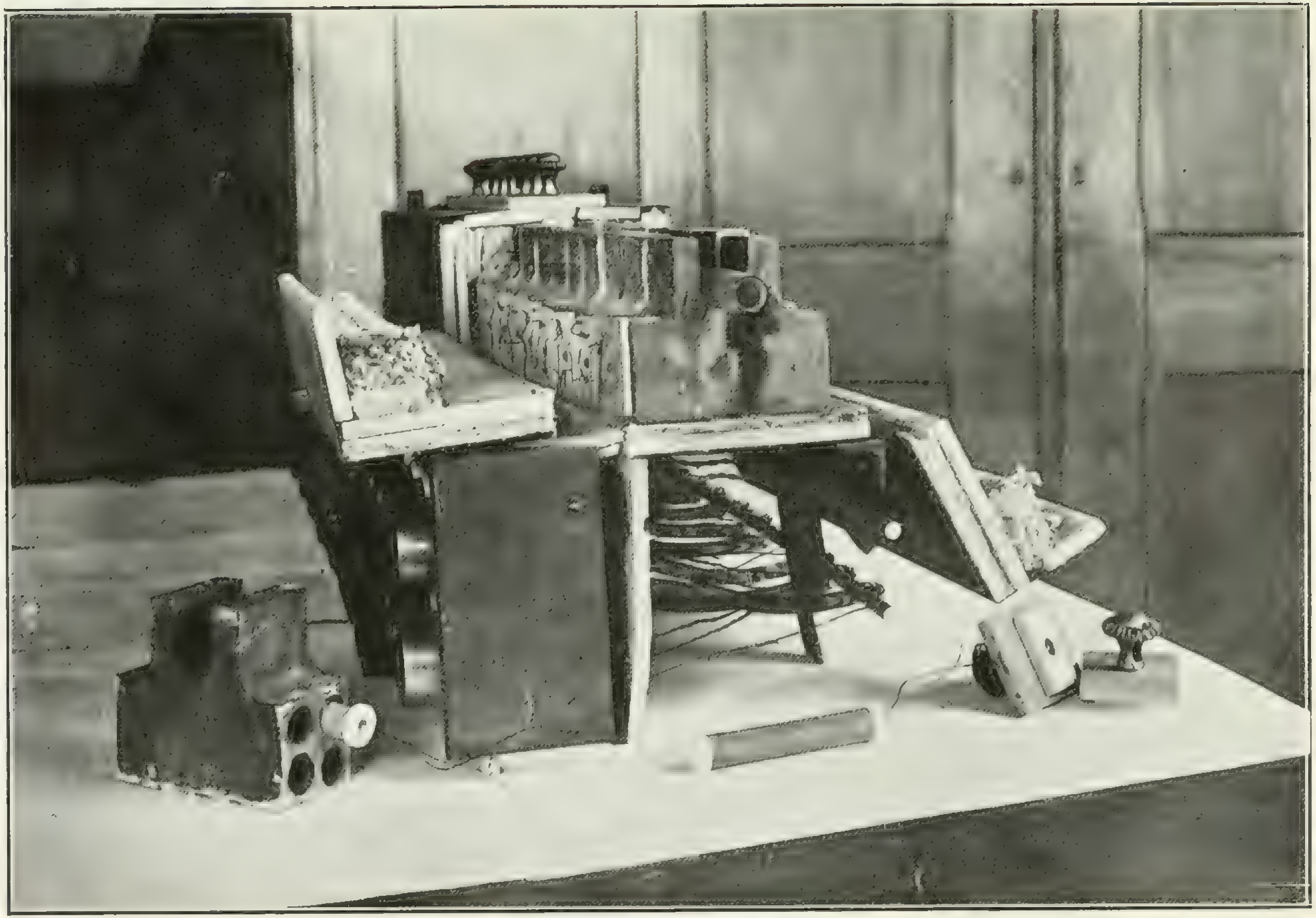
(*b*) Sample dried over sulphuric acid in vacuum desiccator:—

8·7 g. taken, dried for 4 days,		loss	= 40·16	per cent.
" " 7 "	total	"	= 40·60	"
" " 13 "	"	"	= 40·78	"

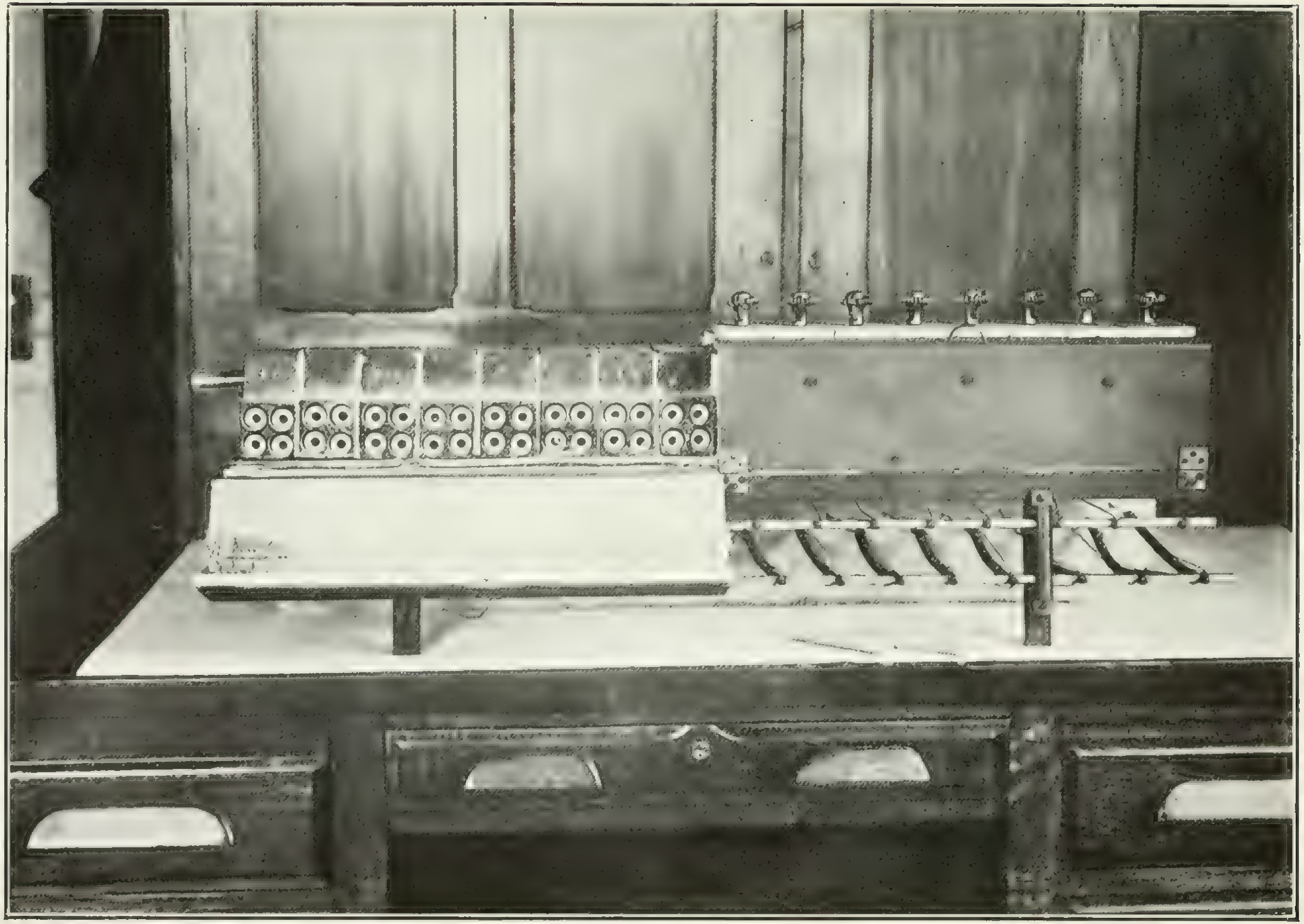
Therefore, over the above periods, hot drying gave a result 0·45 per cent higher than did vacuum drying.

(*c*) Sample burned in calorimeter.

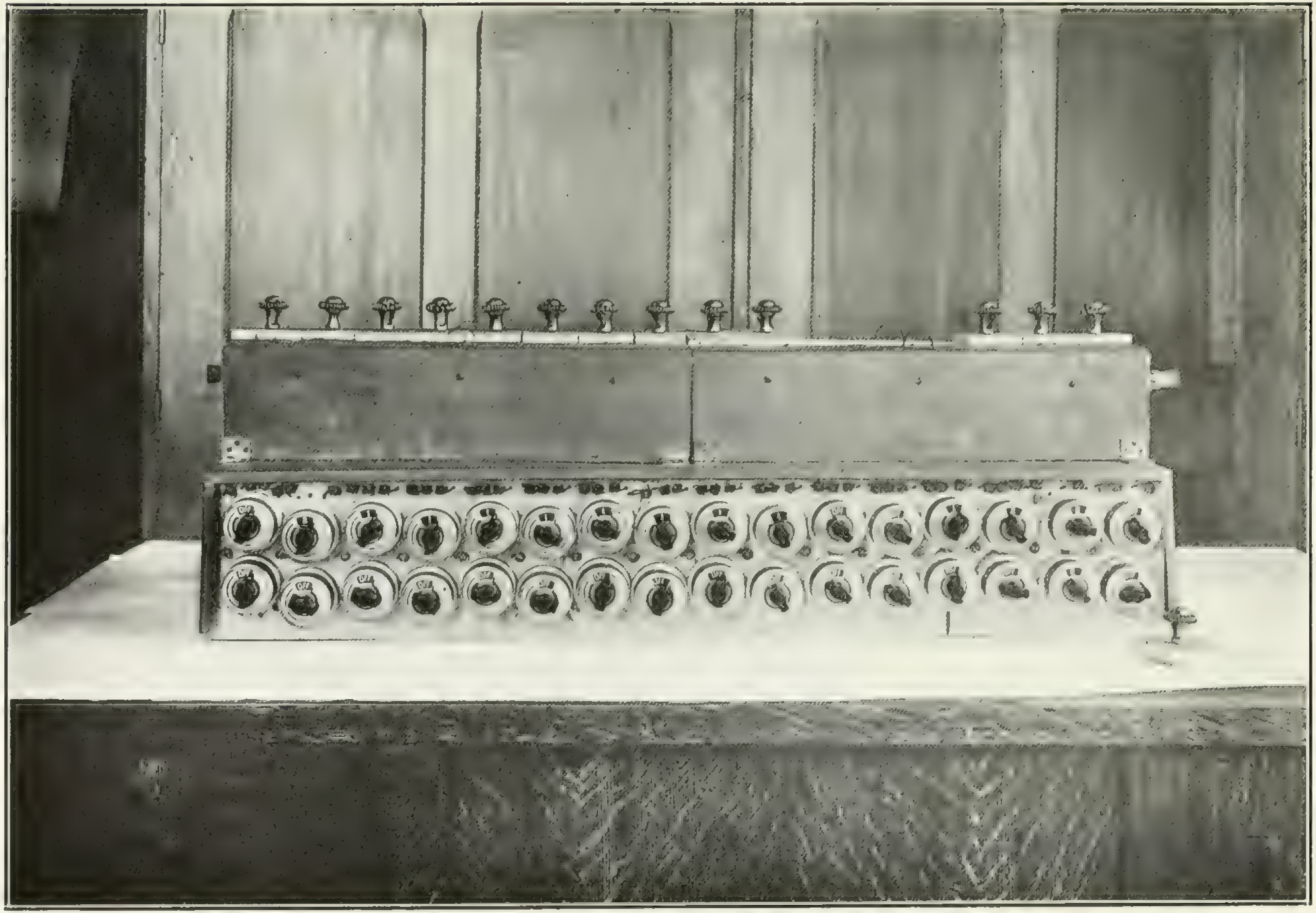
Two determinations of calorific value were made on the briquettes as prepared; the briquettes for these determinations being weighed as soon as made, but not burned until the following day. They would meanwhile have lost moisture, and the results were calculated on their weight when made. A third determination was made two days later when the briquettes had lost 36·03 per cent moisture in a vacuum desiccator. The remaining briquettes were then heated for 4 hours at 110° C., as a result of which a total of 40·42 per cent moisture was driven off, and a fourth determination was then made. The briquettes still remaining lost 0·14 per cent of their original weight when heated for a further 5 hours in the oven, that is, a total of 40·56 per cent of moisture was determined. The original peat sample probably lost some of its moisture whilst it was being briquetted, which would account for this result being slightly lower than that found above. The results were as follows:—



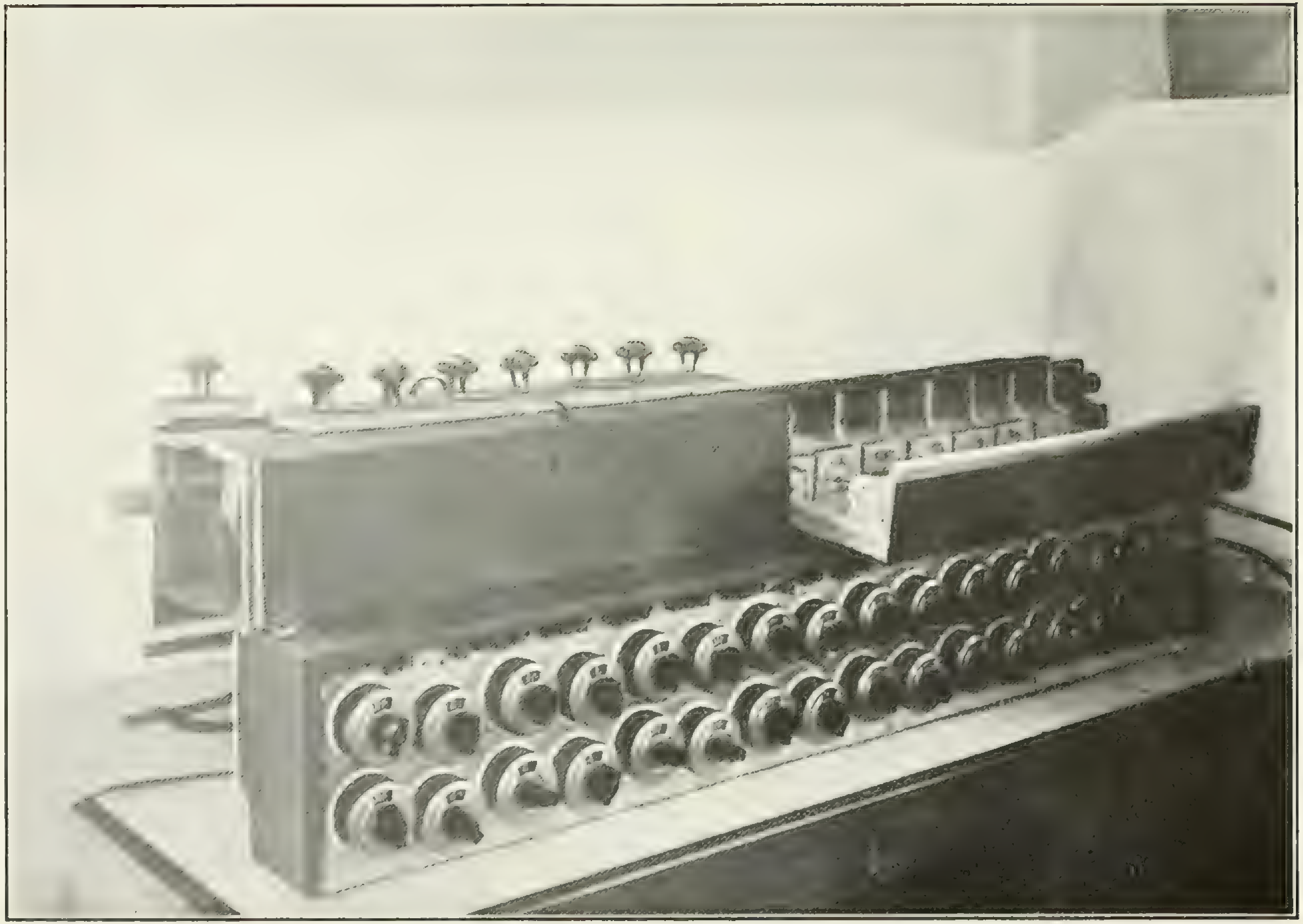
Electric tube furnace---end view.



Electric tube furnace---back view.



Electric tube furnace---front view.



Electric tube furnace---set up for use on tiled table.

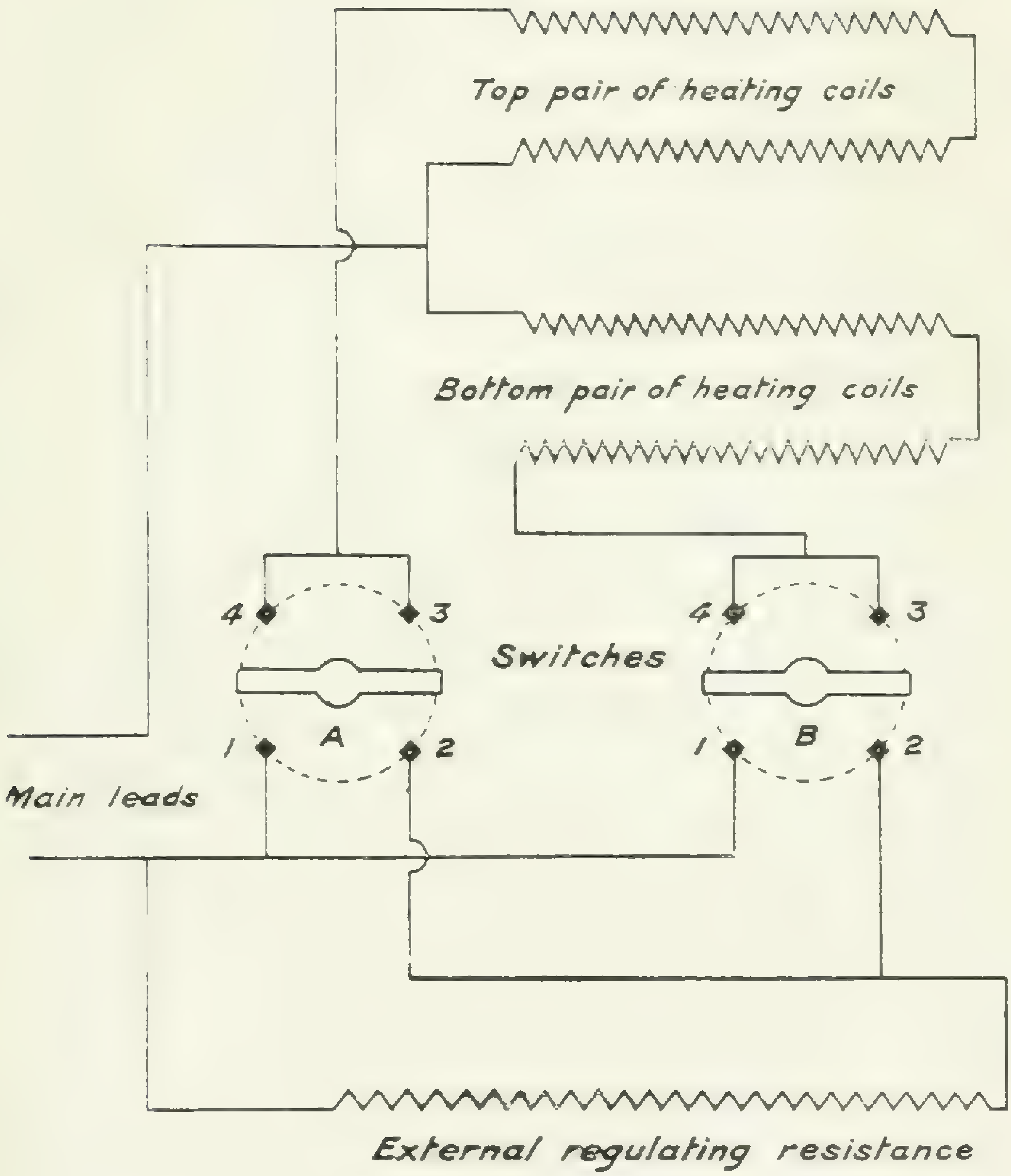


Fig. 6. Wiring diagram for Electric Furnace.

25a — p. 158

Determination.	Water in briquettes when weighed.	Calorific value as determined.	Calorific value corrected to dry peat.
			Cals. per gram.
(1)	40·56	3133	5270
(2).............	40·56	3137	5277
(3)....	7·08	4928	5304
(4)	0·24	5261	5274

The third determination is a trifle high, but the other three agree better than would be expected from a consideration of the probable errors of experiment.

II.

REPORT OF TESTS ON PYRENE.

Sample received about September 1, 1911, from the Whyte Railway Signal Company, Limited, of Toronto. Sample consisted of a quart tin, containing a liquid, labelled "Pyrene ...., Ontario May-Oatway Fire Alarms, Limited, Toronto."

The liquid was brown in colour with a not unpleasant, ethereal odour, somewhat resembling that of chloroform; exposed to the air, it rapidly evaporates, leaving behind a brown, resinous residue.

It was not soluble in water, but readily dissolved in alcohol or ether.

A chemical examination showed that it contained carbon, chlorine, and a trace of hydrogen.

Upon distilling a portion of the sample, it was found that it began to boil at 66° C. (151° F.). The boiling point of the liquid rose gradually, but about 95 per cent distilled over below the temperature of boiling water. It was not found possible to separate the liquid into two or more different constituents, even after twice redistilling fractionally, as the boiling point of the liquid rose without any marked jumps from about 66° C. (151° F.) to 80° C. (176° F.). The specific gravity of the distillate also rose at the same time. Pyrene has a specific gravity of 1·56; the first fraction taken, namely, that boiling between 66° and 71° C., had a specific gravity of 1·525, whilst the largest fraction taken, namely, that between 74° and 80° C., had a specific gravity of 1·589. On continuing the distillation of the small residue left which had a boiling point above 80° C., the temperature rapidly rose to about 150° C. (300° F.), when the residue began to decompose with the evolution of choking fumes of hydrogen chloride (hydrochloric acid gas).

From the above and other tests, it was concluded that pyrene consists mainly of carbon tetrachloride (which boils at 76° C. and has a specific gravity of 1·591), together with other compounds of a similar character.

No injurious effects of any kind were observed from smelling pyrene; although tests were being carried out on it in a small laboratory during a period of several days, and, as already stated, it is a readily volatile liquid. If pyrene is thrown on a hot fire, however, fumes of hydrochloric acid are produced, as described above; these fumes, although choking and irritating, are not actively poisonous.

The value of pyrene as a fire extinguisher appears to lie in the fact that it neither burns nor supports combustion, moreover, as it readily volatilizes at low temperatures, if thrown on a fire, it will rapidly vaporize, forming a heavy vapour.

which, by displacing the air, will prevent the continuation of combustion. It will not materially cool the fire zone, so that if the fire were in a draughty place, the vapours would soon be blown away and the fire continue almost unchecked.

Assuming that pyrene were entirely carbon tetrachloride, one imperial quart of it would weigh about four pounds. If heated to the temperature of boiling water under normal barometric conditions, this would form a vapour about five and one-half times as heavy as air under the same conditions, which would occupy a volume of about 12½ cubic feet. Any decomposition of the liquid to form hydrogen chloride would increase the volume of gas produced, but, as stated above, it does not appear probable that more than 5 per cent, at the outside, decomposes when heated.

III.

AN ELECTRICALLY HEATED TUBE FURNACE, SUITABLE FOR MAKING ULTIMATE ORGANIC ANALYSES.

A tube furnace for ultimate organic analyses, and such as is commonly known as a combustion furnace, should fulfill the following conditions: the temperature should be under full control at any point throughout its length; the furnace should be arranged so that it may be possible to inspect at any time any part of the tube which is being heated; and also, if required for the analyses of easily volatile material, such as coal, the furnace should be at least 32 inches long. Many types of gas-heated furnaces are made which satisfy the above requirements, but the writer was unable to find any description of a satisfactory, electrically heated furnace of this kind. He, therefore, designed the furnace described below, which was subsequently built by the Dominion Electric Company of Ottawa.

In the gas-heated combustion furnace there are frequently as many as twenty-four burners arranged along the length of the furnace, each of which burners can be separately controlled. In the electric furnace referred to above there are sixteen heating sections, each separately controlled; it would neither have been easy, nor did it seem desirable, to have a greater number of smaller sections.

The heating resistance for each section consists of four coils of a nickel-chromium wire known as nichrome. Each heating coil contains about 14 feet of No. 22 gauge wire wound on a threaded fireclay bobbin 4¼″ long and ⅜″ diameter, and having a flange at each end of almost ⅞″ diameter. These heaters, of which spare ones are illustrated in Plates V and VI, were employed because they are a commercial article, being manufactured in large numbers by the Dominion Electric Company for use in their various electrically heated devices.

Each section of the furnace consists essentially of an iron casting about 2″ wide, 4¾″ from back to front, and 3⅞″ high. A slot in the top of the casting forms a part of the bed which supports the tube while it is being heated. This slot is sufficiently large to receive any tube up to ⅞″ diameter. Four holes, each of ⅞″ diameter, pass from front to back of the casting and serve as receptacles for four of the heaters described above. A spare casting is shown on the left in Plate V. Plates V, VI, and VIII show the manner in which sixteen of these castings are bolted together with layers of asbestos between them, to form the complete furnace.

The iron castings rest on asbestos on a stand about 6″ high. They are also completely surrounded with asbestos, except at the two ends (which are never required to be more than warm) and over the trough in which the tube to be heated is placed. This trough can, however, be covered with a number of small lids made

of asbestos board, and which lids can easily be lifted when it is desired to inspect the tube at any point. In order that the furnace may be cooled, at either end, between two experiments, the asbestos cover for the sides and top is made in four parts, two in front and two behind. These covers are so hinged that each may be separately turned quite clear of the furnace proper. The packing of asbestos board, sheet, and rope in each part, is fastened to a sheet of iron, bent at right angles, which has a handle on the top and is connected by hinges at the bottom to the frame work of the furnace. Plates V, VI, and VIII show the furnace with one end thus opened out to cool; Plate VII shows the furnace entirely closed for heating, except that three of the lids over the trough are not in place. The overall dimensions of the furnace are —length, 36″; height, 13½″; thickness from back to front, 12″.

The electrical connexions are shown diagramatically in Fig. 6. The furnace is designed for use with either alternating or direct current at 110 volts, the current being supplied to the two aluminium bus bars which run the length of the furnace behind. In each section the top pair of heaters are connected in series and controlled by a two-way switch; the bottom pair are similarly connected and separately controlled by another two-way switch. Underneath each section there is a regulating resistance, consisting of an exposed coil of nichrome wire. This resistance can be connected in series with either or with both pair of heaters, thus reducing the current which passes through them. Thus, in Fig. 6, when the switch A is turned so as to connect points 1 and 3, full current passes through the top pair of heaters, whilst when the switch is turned to connect points 2 and 4 a reduced current passes through. Switch B similarly controls the bottom pair of heaters. The switches are of the indicating type, so that it is possible to see at once, as is shown in Plate VII, exactly what current is being used for each section. The switches are mounted on an asbestos board, supported several inches in front of the furnace proper, to prevent them from getting too hot.

The resistance of a pair of heaters is approximately 35 ohms and that of the external regulating resistance is 10 ohms. Thus the following five different currents can be passed through any section:—

Both pairs of heaters full current..............................	6·3 amperes.
One pair full current, the other pair reduced current..........	5·6 "
Both pairs reduced current..................	4·0 "
One pair full current, the other pair no current..............	3·15 "
One pair reduced current, the other pair no current..........	2·45 "

The above currents are calculated for 110 volts across the bus bars. The resistance of the nichrome wire was not found to change noticeably with change of temperature. It is possible to pass about 100 amperes through the furnace, but in an ordinary combustion experiment it is never necessary to employ more than about 50 amperes.

In actual use the furnace has been found to work very satisfactorily. When commencing a combustion, the operator can turn full current on to the sections under the copper oxide in his tube and go to the balance room to make the necessary weighings, leaving the furnace entirely without attention for about half an hour. At the expiration of this period the tube will be hot enough to proceed with the combustion. If the current is now reduced to the possible minimum (2½ amperes) in all sections, with the exception of one at each end, of the heated length, the temperature is maintained almost without change. The subsequent rapid heating of the front end of the tube, and the very gradual heating of that portion of the tube in which the substance being analysed is situated, can also be readily controlled. The most serious disadvantage yet noticed is the time the furnace takes to cool; it does not seem possible to reduce the temperature of one end of the furnace, from a red heat to a temperature at which the tube can be touched by the hand without inconvenience, in less than about two hours.

The furnace has not yet been used for a sufficient length of time to enable any statement to be made with regard to its probable life, although previous experience with the type of heater employed has been satisfactory. Up to the present time no heaters have burnt out, but in such an event any one of them could easily be replaced in a few minutes at only a slight cost. The resistance wire on the bobbin is so close to the iron to be heated by it that there is comparatively little risk of local overheating of the wire, and at the same time the flanges at the end of the bobbins hold the latter in place and prevent the wire coming into actual contact with the iron. The electrical connexions are situated in as cool a position as possible.

A hard glass tube heated in this furnace appears to be less damaged than when heated to the same temperature in an ordinary gas-heated furnace, and the risk of breaking the tube through too sudden heating or cooling is reduced to a minimum.

I.

REPORT ON THE EXPLOSION OF AN EXPLOSIVE AT SAND POINT, ONTARIO.

J. G. S. Hudson.

On April 27, 1911, an explosion of explosives took place at the explosives factory operated by Dominion Explosives, Limited, at Sand Point, near Arnprior, in the Province of Ontario.

This explosion, which occurred in the drying-house at 1.20 p.m., resulted in the death of four employes, namely:—

Horace McMullen,
Joseph Mills,
Donald Bennet,
William Brooks.

An explosion of explosives, of which an account appeared in the Summary Report of the Mines Branch for 1910, had also occurred in the same factory on July 11, 1910, and had resulted in the death of three men.

Following the explosion of April 27, 1911, an inquest on the death of the men killed was held at Sand Point, on May 2. On that occasion the Coroner's Court consisted of:—

Dr. Armstrong, Coroner.
J. B. Metcalf, Esq., Crown Attorney.
G. F. Henderson, Esq., K.C., and J. E. Thompson, Esq., appearing for Dominion Explosives, Limited.
Mr. Foy, representing relatives of the deceased.
Miss Isabella Dewar, stenographer.

The evidence submitted was of a very exhaustive character. Every detail which had any bearing on the process of manufacture, the discipline as carried out at the works, and the precautions taken for the prevention of accidents, was inquired into by Mr. Metcalf, the Crown Attorney for the county of Renfrew.

After the explosion of July, 1910, no explosives were manufactured at this factory until the month of January, 1911. Meanwhile the management of the Company reconstructed the whole plant. In this rearrangement, and in order to safeguard building and lives of employes against possible future explosions, special attention was paid to the distances separating the various buildings in which manufacturing was carried on.

The process of manufacturing the explosive known as "Blaster's Friend"—the product of the Dominion Explosives Company—is fully explained in the Summary Report of the Mines Branch for 1910. The evidence of Mr. Machette, the superintendent, may, however, be taken as describing generally the formulæ used in the manufacture of this explosive.

The base of the explosive known as "Blaster's Friend," is Cassava flour—a residue from the manufacture of tapioca. This flour is treated with a mixture composed of sulphuric and nitric acids, together with nitrate of soda and machine oil. After the flour has been subjected to this treatment, it is washed in a solution of

ammonia made up in the proportion of twenty pounds of ammonia to three hundred and sixty pounds of water, this solution being used to neutralize the acid previously taken up. The mixture is then put into a centrifugal whizzing machine in order to extract as much water as possible, after which the pulp is conveyed to the drying-house.

In this drying-house the damp pulp is spread on screens, which are then placed in a closet through which a continuous circulation of air is allowed to flow. This air has a temperature of 100° F. at the entrance of the ductet and of 90° F. where it enters the drying-house. It was in this building that the explosion, which resulted in the death of the four men named above, occurred.

It is apparent from the evidence that on each occasion when explosions have occurred, namely, on July 11, 1910, and on April 27, 1911, the explosion was generated in the drying-house. It was brought out in the evidence that the air being circulated through the drying-house had to be maintained at a temperature of 100° F. as a maximum which would give 90° F. at the end of the ductet. But it was also stated by the superintendent of the works—Mr. Machette—that he had seen the temperature recorded up as high as 120°-130° F., and when asked directly by the Crown Attorney whether he considered that temperature dangerous—replied that he did not.

Mr. Ogden, the chemist, in his evidence states that he had repeatedly heated samples of the wet pulp taken from the drying-house, to a temperature of 212° F. for a period of an hour or an hour and a half. "That I have done repeatedly with the powder, but it never showed signs of decomposing, and to put it to an extreme test after this (accident) happened, I took some of the powder as it stood in the mixing-house right after it had come from the dry-house and heated it for about seven hours at the boiling point of water, 212 degrees, and there was no apparent decomposition of the powder—it was still in apparently the same condition, that was at 212." Mr. Ogden then explained a physical test applied in the laboratory of the works.

Question by Crown Attorney to Mr. Ogden:

"Now, have you been able to cause an explosion of this powder at the dry-house stage—of course, we were always concerned with that—by anything short of fire? I know the doubt that's on your mind and I promise you to come to that in a moment. Perhaps I had better come to it first. Tell me, tell the jury about your test with the anvil and hammer. You took a very small amount of this powder first of all, and put it on an anvil and struck it with a hammer, and first tell me the result.

Answer by Mr. Ogden:

"With a very small quantity, hitting it a hard blow with the hammer on the anvil, there would be——"

Q. Well, now, just what did happen?

A. By Ogden, There would be a crack, a detonation.

Q. An explosion?

A. An explosion?

Q. You could detect an explosion?

A. Yes. When Mr. Lumsden took a large amount sufficient to form a cushion between the hammer and the anvil, probably a quarter of an inch, and it wouldn't explode, that little cushion on the anvil wouldn't set it off, but a very small layer on the anvil would, that would set it off. In fact, apparently the other extreme seemed to be the fault of the powder, that it required a slightly stronger cap to set it off."

It was also shown in the evidence that a man named Sproule was reported to have had a match in his possession while at the works, but on cross-examination this possession of a match was denied.

Cross-examination by Mr. Metcalf, Crown Attorney:

Q. "Were you searched that morning at the office?

A. No, sir.

Q. Are the men not searched every time when they go in?

A. No.

Q. Don't you report every morning at the office, before you go to work?

A. We go to the office and take everything off that we have on.

Q. Well, did you do that, Mr. Sproule?

A. Yes, sir.

Q. You did that?

A. Yes, sir.

Q. And are you prepared to swear positively that you had no sulphur match about your person?

A. Yes, sir.

Q. At the time that Bennett saw you and spoke to you in front of the mixing-house?

A. Yes, sir.

Q. That there was no sulphur on that match whatever—when had it been discarded?

A. When, I don't know.

Q. Well, had it been broken off; I mean before you went to the works?

A. Oh, yes, sure.

Q. Do you swear to that?

A. Yes, sure.

Q. So that the discarded head didn't and couldn't fall on one square inch of the ground of the factory?

A. No, sir.

Q. That's all I want to know. You swear to that?

A. Yes, sir."

As is so often the case in an explosion of an explosive during the process of manufacture, very little information is available, regarding the exact conditions and the actual cause of the explosion. It was shown by the evidence that the Dominion Explosives Company had in their employ an explosives chemist whose duty it was to analyse the ingredients composing the explosive known as the "Blaster's Friend," and that on several occasions he had applied a "heat test" to the compound at certain stages of manufacture. It was also shown that he had applied physical tests for percussion. While these tests might be carried out under the chemist in charge, and under the personal supervision of the superintendent of the works, yet it must be apparent that these tests, carried out in the laboratory of the factory and by employes of the Company, could not in any way compare with the chemical and physical tests to which an explosive would be subjected in a testing station such as that provided for under the Explosives Act for Canada and administered by the officers of the Explosives Division of the Mines Branch.

Owing to the fact that no Explosives Act for Canada has as yet been enacted, and since they thus have no legal status, members of the staff of the Mines Branch attending inquests such as the above are placed in a difficult position. Thus, we are repeatedly asked by the Coroner and by the jurymen why certain conditions exist, and we are requested to express a more direct opinion as to the exact cause of these accidents. The only answer that we can give is that we are unable to do either; that there is no law on our statute books whereby a manufacturer of an explosive is under any obligation whatever to give any information as to the composition of his explosive; that until an Explosive Act is passed by the Federal Government of Canada, we have not the authority to examine either chemically or physically explosives manufactured, imported, stored, or used in Canada.

Such a condition as this does not exist under any other modern progressive government and should not exist in Canada.

The Jury, after hearing all the available witnesses, rendered the following verdict, namely:

"We find that William Brooks came to his death on April 27, on the premises of the Dominion Explosives, Limited, near Sand Point, with whom he was employed, as a result of an explosion in the building known as the dry-house, but from what cause the explosion occurred we are unable from the evidence submitted to determine.

"For the better protection of human life and property and to minimize the danger of a recurrence of such a catastrophe we recommend:

1st. "That until such times as the public road bordering on their premises be changed to the south side of the Canadian Pacific railway, the Dominion Explosives, Limited, be prohibited from operating their plant or to manufacture the explosives known as the 'Blaster's Friend.'

2nd. "That in the event of the Dominion Explosives, Limited, being permitted to resume operations, we recommend that greater precautions be taken by all the employees, including the Superintendent.

3rd. "That all employees be searched for matches and other dangerous articles every day before being allowed to work.

4th. "That direct and instant communication be established between the dry-house and the building where heat is generated for said dry-house, that the overseer in charge of the works be made a responsible agent for the Dominion Explosives, Limited, for the safety of their employees."

After this explosion occurred the President of the Dominion Explosives Company employed Mr. Leo Guttmann, of Queen's University, and Professor George Munro, of the George Washington University, to report on the processes employed in the manufacture of their explosive. These reports were of a confidential nature and not available for publication.

II.

REPORT ON THE EXPLOSION OF AN EXPLOSIVE AT BELŒIL, QUE.

On Saturday, September 23, 1911, an explosion of explosives occurred at an explosives factory, operated by the Canadian Explosives Company, at Belœil, Quebec. As a result of this explosion, one man was killed outright, while four other employes were seriously injured.

The men seriously injured by this explosion are in the hospital, and their injuries may prove fatal.

The names and ages of the men killed or injured are as follows, namely:—

William St. George, age 28, died.
Maurice Menard, age 18, badly burned.
Casmir Williams, age 39, slightly burned.
Alphonse Duquette, age 22, painfully burned.
Arsene Williams, age 21, painfully burned.

I have been informed that three of the above-named men have succumbed since the day of the accident to their injuries.

The accident occurred in one of the explosives factories operated by the Canadian Explosives Company, Limited, Head Office, 4 Hospital Street, Montreal.

This Company has lately taken over under its management the explosives factories of the Hamilton Powder Company, of the Standard and Western Explosives Companies, and of the Ontario Powder Company.

The factory in which the explosion occurred, was formerly operated by the Hamilton Powder Company, and is one of the oldest and largest plants owned by the Canadian Explosives Company. It is situated on the Richelieu river, near the village of Belœil, in the Province of Quebec, and is in close proximity to the railway line of the Grand Trunk from Montreal to Lévis.

The explosion occurred in one of the packing-houses of the plant.

These packing or punch-houses are used for the purpose of holding the machines which pack the explosive, after it has been mixed, into the paper cartons which, when complete, are designated as cartridges, being of specified diameter and length to meet the explosives trade requirements.

The explosive is conveyed from the mixing-house to the packing-house in wood-fibre buckets, containing such quantities of explosive as may be conveniently handled with the least degree of danger.

When the explosive has been received from the mixing-house, it is placed in a machine, operating a series of shuttles, designed to fill the paper cartons with explosive, evenly and with a uniform degree of compactness.

These packing or punching machines employed in explosives factories are usually of three types, namely, hand operated, those operated by power from belt transmission, and a large shuttle type of large capacity and power.

The explosion occurred in a packing-house, in which the machines were of the belt-driven type. Following a universal custom pursued in explosives factories, at the end of the days' work all parts of the machines and interior of the buildings are cleaned up, so that no loose explosive is left lying round which might constitute a danger.

The men who were killed and injured by the explosion at Belœil on Saturday afternoon were employed doing this work, consequently only a comparatively small quantity of explosive was in the building when the explosion occurred. From the information furnished by the Assistant Superintendent of the works, I gather the following account of the explosion:—

On Saturday afternoon the supply of explosive being conveyed from the mixing to the packing-house was stopped to allow the men working in the packing-house to finish putting into paper cartons the quantity of explosive already received. When this quantity of explosive should have been made up into cartridges, the usual cleaning up of the machine and interior of the building was to have been proceeded with. On account of the day being Saturday, an extra length of time is allowed for this work, as the machines and buildings have to stand over Sunday. Additional supervision and care are taken on this account in preparation for the commencement of work on Monday morning.

As far as can be estimated the quantity of explosive in the building would not exceed 150 pounds in weight.

Apparently a fire originated, possibly due to the friction of a rapidly-moving belt, but this can only be surmised, since, as unfortunately happens in the majority of accidents in explosive factories, the men who might give positive evidence of what took place are either killed or fatally injured.

From the available evidence given by some of the men, who were able to tell the manager of the works their version of the occurrence, it appears that they noticed a fire in the building, and endeavoured to the best of their ability to extinguish it. Coming to the conclusion, however, that it was beyond their power to do so, these men tried to make their escape from the zone of danger, and ran out of the building

The fact that they were but a short distance away when the explosion did take place, proves that they fought the fire and remained at their posts until the very last moment.

The explosion completely wrecked the building, practically nothing being left.

The men were injured by burns and shock, as, when they were found, their clothing was burning, and it took some time to extinguish the flames.

After visiting the scene of the explosion, I made inquiries as to where the inquest (if any), relative to the death of William St. George, was to be held. I was informed that the Coroner at Montreal had made an investigation, and that the evidence given by Mr. Wilson, the Works Manager, was so explicit that the jury rendered their verdict without further inquiry.

I may state that the explosives plant operated by the Canadian Explosives Company at Belœil is affiliated with the works of the Nobel Explosives Company of Great Britain. The methods of manufacturing explosives are based on the practice as carried out at the Ardeer factories, which constitute one of the largest explosives establishments in Great Britain, and are licensed under the Act regulating the manufacture of explosives in that country.

During my several visits to the factory at Belœil, I have, through the courtesy of the manager, had an opportunity of observing the care with which explosives and ingredients thereof are handled at this factory.

The information contained in this report has also been obtained through the courtesy of the manager, as, owing to the fact that the Explosives Bill had not yet been passed, I had no authority to require the information. In fact, I was forbidden to take photographs inside of the factory grounds.

III.

REPORT ON THE EXPLOSION OF AN EXPLOSIVE AT RIGAUD, QUE.

On October 19, 1911, an explosion of explosives occurred at the explosives factory of Curtis and Harvey of Canada, Limited. This factory is located between the town of Rigaud and Graham landing, on the Ottawa river. It is in close proximity to the Ottawa-Montreal short line of the Canadian Pacific railway, between Rigaud and Lavigne station. This factory was, until within the last year, operated by the Northern Explosives Company. In December, however, that Company entered into an arrangement with Messrs. Curtis and Harvey, of London, England, whereby the management of this plant was to be taken over. This arrangement was made in order to give to Messrs. Curtis and Harvey the control of an explosive plant already established in this country, and from which they might supply their long established and increasing explosives trade in Canada.

On acquiring this plant and property, Messrs. Curtis and Harvey notified the Explosives Division of the Mines Branch that they were aware of the fact that an Explosives Bill, to regulate the Manufacture, Importation, Storage, and Testing of Explosives in Canada, had been prepared, and was to be laid before the House by the Minister of Mines during the current session of Parliament. In view of the fact that the Explosives Act for Canada, in many of its salient features, would be based upon the findings of the Explosives Act of Great Britain, the management of Curtis and Harvey of Canada deemed it advisable, in the rearrangement of such buildings as then existed, and also in the contemplated construction of new buildings within their factory site, that the Tables of Distances, as authorized by the Explosives Department of the British Home Office, should be adopted.

In carrying out this policy, the Company were necessarily placed for the time being under considerable financial loss, their output of explosives being curtailed, until new buildings and improved methods of manufacture could be established.

The adoption of this policy by Messrs. Curtis and Harvey, a firm long established in the explosives trade, must be regarded as satisfactory evidence of their approval of the proposed establishment of the Explosives Act of Canada.

The topography of the site, on which the plant of the Company is situated, offers certain natural advantages for the location of an explosives factory. Thus, for example, by placing many of the danger buildings in close proximity to the hill sides, advantage has been taken of the undulating character of the ground. In case of an explosion in factory danger buildings or in magazines, the protection of natural mounds is in this way obtained. Consequently, buildings containing explosives or their ingredients, which, being wholly or partially mixed, are in a more or less dangerous state as to sensitiveness to percussion, friction, or concussion, are afforded very material protection from flying debris. This fact was strikingly demonstrated when on October 19, 1911, a quantity of 60 per cent dynamite, estimated as being equivalent to one ton, exploded in the Company's mixing-house. The accompanying photographs (Plates IX to XVI), taken on the occasion of the writer's investigation, indicate the value of such protection to buildings even when situated in close proximity to the explosion.

Moreover, on the site of the danger buildings there is also a considerable amount of thick underbrush and numerous closely-growing trees. The effects of the rush of air, propelled by the explosion in the mixing-house, is illustrated in photograph Plate XIII, in which trees of considerable size and diameter are shown as having been uprooted.

In the manufacture of their explosives, the management of Curtis and Harvey exercise due care, the works manager, chemist, and foremen being men of experience in this business. The apparatus, implements, and receptacles used in the several processes of manufacture are also of the best and most improved type. The same care is seen in the fact that floors and interiors of buildings are lined with rubberoid, that doors of danger buildings open outward, in the use of wooden mixing shovels, rakes with rubber-tipped teeth, and wood-fibre tubs protected with rubber buffers for conveying the ingredients of explosives, and in a general absence of iron in implements used.

Well-defined and explicit rules and regulations are posted up in the buildings and in conspicuous places for the guidance of the employes.

INVESTIGATION OF ACCIDENT.

On Tuesday afternoon (October 19, 1911), I was called up on the long-distance telephone from Montreal, and informed by Mr. J. J. Riley, the General Manager of Curtis and Harvey of Canada, that an explosion of explosives had occurred in the mixing-house of their plant at Rigaud, Que., and that as far as could be ascertained at the time, four men had lost their lives. I mention this fact since this was the first instance in which the Department had been officially notified of an explosion of an explosive in a factory in Canada. In accordance with instructions, I proceeded by the first train on Wednesday morning to Rigaud, where the bodies of the men who were killed by the explosion on the day previous were being viewed by the Coroner and jurymen. After viewing the remains, the inquest was adjourned until the following week. I then proceeded in company with Mr. Louis Guyon, Chief Inspector of Industrial Establishments and Public Buildings, Montreal, and inspected the site on which the building known as the mixing-house had stood previous to the explosion.

On arriving at the plant we were informed by the management that, with the exception of the nitrating house, which on account of the spilled nitro-glycerine had

to be protected, the buildings and appliances were in the same condition as they were immediately after the explosion. We were further given to understand that the management, officials, and workmen were at our disposal, that they would willingly answer any question which we might desire to ask, relating to the explosion or cause thereof, and that I was at liberty to take photographs.

Plans showing the location of the buildings, together with detailed plans of the buildings themselves, were on view at the office for our information. The manager, works manager, and foreman accompanied us on our inspection, explaining fully the several methods of conveying the ingredients of the explosives from one building to another, and also the precautions taken to minimize the danger of an explosion in the mixing-house.

The works manager informed me that he had visited this mixing-house a short time previous to the explosion and that he had not detected any disarrangement of any apparatus. He further stated that no unusual occurrences had arisen in the ordinary working methods whereby the accident could be accounted for, adding that he was extremely anxious to obtain any clue which would lead to a satisfactory solution of what might have occurred, not only on account of its immediate bearing on this accident, but that the management might be in a position to guard against similar occurrences in the future.

On the morning on which the explosion occurred, at seven minutes before 12 o'clock, provided the usual works practice was being adhered to, Napoleon Castonguay and Eugene Seguin should have been inside the mixing-house, while A. Sevigny and Wilfred Malette should have been on the outside. As, however, all of the above-named employes were killed instantly, their relative positions will never be determined. Two other employes, Emile Faubert and Elsezar Thauville, who were working at a distance from the mixing-house when the explosion occurred, were slightly injured by the flying debris.

They were not in a position to give any definite or conclusive evidence as to what really happened in the mixing-house when the explosion occurred.

The man who was employed in the nitrating house (*see* plan for relative location) states that he is positive he heard a slight explosion previous to the heavier one which showed such disruptive force, and he evidently knew that a much heavier explosion would follow. Being a man of considerable experience, he, therefore, adopted a wise precaution, and on hearing the first explosion, immediately "drowned" his charge of 1,200 pounds of glycerine, which was at the time in the nitrater. It might be inferred from the evidence of the man who was in the nitrating house, that in handling the ingredients which made up the estimated quantity of 2,000 pounds of 60 per cent dynamite which exploded, a small portion of the explosives mixture, from some cause at present unknown, exploded with sufficient force to detonate the larger quantity of explosive contained in the mixing-house. It was the explosion of this larger quantity that caused the loss of life and the damage to buildings.

Mr. McMahon, the Coroner for the district of Montreal, held an inquest on the bodies of the men who were killed by the explosion. At this inquest, Mr. J. J. Riley, the General Manager, Mr. Barnes, the works manager, and eighteen employes of the Company gave evidence. Mr. L. Guyon, the Inspector of Industrial Establishments in the Province of Quebec, also attended and gave evidence.

At the inquest, Mr. Riley gave the following statement, as quoted in the *Montreal Star*, of October 20, 1911:—

"Mr. James Riley, manager of the firm, declared in his evidence that since the Company began business at Rigaud, its plant and premises had never either been visited or inspected by any Government Inspector or other official." In connexion with this statement, reference should be made to the fact that until the Explosives Act for Canada is passed, no one has the authority or power to inspect this class of factory. Mr. Guyon, the Inspector of Industrial Establishments for the Province of

Quebec, informed the writer that his assistant inspectors objected most strenuously to going into explosives factories. I am, moreover, of the opinion that they are right in their contentions and that, if they are not familiar with this hazardous class of work, they have no more necessity for going into explosives factories than the general public.

Commenting on this accident, the *Montreal Star*, in its issue of October 20, 1911, editorially remarks: "In such investigations as that which must be made into yesterday's explosion at Rigaud, the public has more than an indirect interest. Explosives factories at their best are a menace to those whose business calls them within a very considerable radius of the plant itself, as well as to the workmen actually employed there. It is well to have it made clear after such an incident whether or not everything has been done to make an explosion improbable in the first place, and to minimize its consequences, should one occur, in the second place.

"There have been enough of such accidents in the vicinity of Montreal during the last few years to make the subject one of considerable interest. The verdict of the jury stated that the accident must have been caused by the carelessness of one of the victims, also that there was no crime to be suspected in the present case."

On several similar occasions in the past, I have drawn attention to the unsatisfactory conditions under which any officer of the staff of the Mines Branch attends investigations and inquests such as the above.

1st. Not having a legal status as inspector, it is only through the courtesy of the Coroner that he can appear as a representative of the Mines Branch.

2nd. He has no official knowledge of the conditions as they exist at the factory before the explosion, and is, therefore, not in a position to give an opinion as to what caused the explosion, nor what precautions might have been taken for its prevention.

Within the last eighteen months, I have investigated five explosions of explosives, each one being attended with fatal consequences and resulting in all in 25 persons being killed. Yet to-day there are no statutes nor any regulations for the efficient inspection of such manufactories, nor any authority for collecting information relative to the accidents or manufacture of explosives in Canada.

MAPS AND DRAWINGS MADE DURING 1911.

H. E. Baine, Chief Draughtsman.

L. H. Cole.—Map of Cobalt, Gowganda, Shiningtree, and Porcupine Districts—$6\frac{3}{4}$ miles to 1 inch.

B. F. Haanel.—Plan of ground floor, Fuel Testing Plant, Section of Gas Producer.

B. F. Haanel.—Three plans Producer Gas Engine, 15 charts.

A. C. Lane, Ph.D.—Map of Geology of Point Mamainse, Ontario, to accompany Bulletin No. 6, Diamond Drilling at Point Mamainse—4,000 feet to 1 inch.

A. W. G. Wilson.—Map of the Great Lakes Region, to accompany report on Pyrites
Twenty-eight drawings of furnaces, etc., for plates.

Hugh de Schmid.—Map showing Principal Mica Occurrences in the Dominion of Canada—100 miles = 1 inch.
Map, showing location of the Principal Mines and Occurrences in the Ontario Mica Area—3·95 miles.
Map, showing location of the Principal Mines and Occurrences in the Quebec Mica Area—3·95 miles.
Nineteen Maps showing Mica Occurrences in the different Townships of Ontario and Quebec.
Six drawings for cuts and plates.

H. Fréchette.—Map of Southwest Part of Torbrook Iron-bearing District, Annapolis county, Nova Scotia—400 feet = 1 inch.

Dr. J. B. Porter.—General Map of Canada showing Coal Fields, 100 miles to 1 inch.
General Map of Coal Fields in Yukon Territory—32 statute miles = 1 inch.
General Map of Coal Fields in British Columbia—35 miles = 1 inch.
Map of Coal Fields in Manitoba, Alberta, and Saskatchewan—35 miles = 1 inch.
Map of Coal Fields in Nova Scotia—12 miles = 1 inch.

E. Lindeman.—Map of No. 3 Mine, Lot 7, Concessions V and VI, Township of McKim, Sudbury district, Ontario—scale 100 feet = 1 inch.
Magnetometric Map, Austin Brook—400 feet = 1 inch.
Geological Map, Austin Brook—400 feet = 1 inch.
Index Map, showing Iron-bearing Area at Austin Brook.
Section of Diamond Drill-holes at Austin Brook.
Not published. Map, Bow Lake Iron Ore Deposits, Faraday township, Hastings county, Ontario—200 feet = 1 inch.
Magnetometric Map, Carlow Sheet, Hastings county, Ontario—200 feet = 1 inch.
Magnetometric Map, Bagot township, Renfrew county, Ontario—200 feet = 1 inch.

Geo. C. Mackenzie.—Map of Dominion of Canada, showing the Magnetic Iron Sand Deposits—100 miles = 1 inch.

Index Map, Magnetic Iron Sand Deposits in relation to Natashkwan harbour and Great Natashkwan river, Quebec—40 chains = 1 inch.

Map, Natashkwan Iron Sand Deposits, Saguenay county, Quebec—250 feet = 1 inch.

Eight drawings for plates and cuts.

A. Anrep Jr.—Plans of Holland Peat Bog, Ontario.
" Fort Francis Peat Bog, Ontario.
" Julius Peat Bog, Manitoba.
" Transmission Peat Bog, Manitoba.
" Boggy Creek Peat Bog, Manitoba.
" Mud Lake Peat Bog, Manitoba.
" Corduroy Peat Bog, Manitoba.
" Lac du Bonnet Peat Bog, Manitoba.
" Rice Lake Peat Bog, Manitoba.
" Litter Bog, Manitoba.

LIST OF REPORTS, BULLETINS, ETC., PUBLISHED DURING 1911.

S. Groves, Editor, Department of Mines.

69. Chrysotile-Asbestos: Its Occurrence, Exploitation, Milling, and Uses (Second Edition)—by Fritz Cirkel, M.E. Published March 30, 1911.

82. Bulletin No. 5: Magnetic Concentration Experiments with Iron Ores of the Bristol Mines, Que.; Iron Ores of the Bathurst Mines, N.B.; A Copper Nickel Ore, from Nairn, Ont.—by G. C. Mackenzie, B.Sc. Published February 10, 1911.

83. An Investigation of the Coals of Canada with reference to their economic qualities: as conducted at McGill University under the authority of the Dominion Government. Report on—by J. B. Porter, E.M., D.Sc., R. J. Durley, Ma.E., and others—
    - Vol. I—Coals: sampling, crushing, washing, mechanical purification, and coking trials.
    - Vol. II—Coals: steam boiler, producer, and gas engine trials, also chemical laboratory work.

84. Gypsum Deposits of the Maritime Provinces—by W. F. Jennison, M.E. Published November 15, 1911.

88. Annual Report of the Division of Mineral Resources and Statistics on the Mineral Production of Canada, during the calendar year 1909—by John McLeish, B.A. Published April 29, 1911.

89. Proceedings of Conference on Proposed Legislation on the Manufacture, Importation, and Testing of Explosives; Held, House of Commons, September 23 and September 30, 1910. Published September 28, 1911.

92. Investigation of the Explosives Industry in the Dominion of Canada, 1910—by Capt. Arthur Desborough. Published: First Edition, February 10; Second Edition, June 14; Third Edition, October 4, 1911.

93. Molybdenum Ores of Canada—by Prof. T. L. Walker, Ph.D. Published November 15, 1911.

102. Preliminary Report on the Mineral Production of Canada for the calendar year 1910—by J. McLeish, B.A. Published February 28, 1911.

103. Mines Branch Summary Report, 1910. Published November 15, 1911.

104. Catalogue of Publications of Mines Branch, from 1902 to 1911: containing Tables of Contents, and List of Maps, etc. Published March 28, 1912.

110. Bulletin No. 7: Western Portion of Torbrook iron ore deposits, Annapolis county, N.S.—by Howells Fréchette, M.Sc. Published February 5, 1912.

111. Diamond Drilling at Point Mamainse, Ont.—by A. C. Lane, Ph.D., with Introductory by A. W. G. Wilson, Ph.D. Published June 24, 1912.

114. Production of Cement, Lime, Clay Products, Stone, and other Structural Materials in Canada, 1910—by J. McLeish. Published December 28, 1911.

115. Production of Iron and Steel in Canada during the calendar year 1910—by J. McLeish. Published December 22, 1911.

116. Production of Coal and Coke in Canada during the calender year 1910—by J. McLeish. Published December 22, 1911.

117. General Summary of the Mineral Production in Canada during the calender year 1910—by J. McLeish. Published December 22, 1911.

118. Mica: Its Occurrences, Exploitation, and Uses—by Hugh S. de Schmid. Published July 10, 1912.

143. Annual Report on the Mineral Production of Canada during the calendar year 1910—by John McLeish. Published May 15, 1912.

150. Preliminary report on the Mineral Production of Canada, during the calendar year 1911—by John McLeish. Published June 1, 1912.

ACCOUNTANT'S STATEMENT.

MINES BRANCH.

Statement of Appropriation and Expenditure by Mines Branch for the year ending March 31, 1911.

	Appropriation.	Expenditure.
Amounts voted by parliament	$189,762 50	
Receipts—		
For sales of peat	2,435 25	
" assays and analyses	528 25	
Civil list salaries		$ 37,098 71
Machinery, labour, etc., peat bog, Alfred		8,313 93
Fuel testing plant, Ottawa		9,480 86
Concentrating laboratory		5,647 82
Metallurgical investigations		5,706 00
Investigations *re* explosives		5,560 69
Publication of reports		5,371 88
" maps		3,934 41
Printing, stationery, books, mapping material		2,925 61
Wages, outside service		2,614 57
Investigations *re* iron ore deposits		2,551 75
Monograph on building stones		2,160 42
Monograph on molybdenum		1,818 70
Investigations, peat and coals		1,944 34
Instruments and repairs		1,997 10
Investigations of copper deposits		1,396 02
Chemical laboratory		1,864 42
Investigations of ore deposits		1,030 28
Miscellaneous		810 20
Monograph on mica		496 [illegible]
Mineral statistics		253 65
Travelling expenses		222 30
Investigations *re* gas producers		198 6[illegible]
Balance unexpended and lapsed		89,297 04
	$192,726 00	$192,726 00

Summary.	Vote.	Expenditure.	Unexpended Balance.
Civil government salaries	$ 39,362 50	$ 37,098 71	$ 2,263 79
Investigations of ore deposits, economic minerals, etc.	44,000 00	27,106 56	16,893 44
Printing, apparatus, chemical laboratories' expenses, books, etc	34,500 00	19,573 07	14,926 93
Operation of peat bog, Alfred, $8,313.93; less sales of peat, $2,435.25	6,000 00	5,878 68	121 32
Investigation of metallurgical problems of economic importance	5,900 00	5,706 00	194 00
Investigation of the manufacture, etc., of explosives in Canada	10,000 00	5,102 44	4,897 56
Zinc investigations per Bill No. 182	50,000 00	......	50,000 00
	$189,762 50	$100,465 46	$89,297 04

Appropriation, 1909-10.
Balance unaccounted for by J. E. Woodman, $100.

(Signed) **Jno. Marshall.**

APPENDIX I.

EUGENE HAANEL, Ph.D.,
Director of Mines.

SIR,—I beg to submit herewith, the annual preliminary report on the mineral production of Canada in 1911, including a table showing the revised statistics of production in 1910.

The figures of production for 1911, while subject to revision, are based upon direct returns from mines and smelters operators and are fairly complete.

Special acknowledgments are due to those operators who have promptly furnished reports of their operations during the year.

When complete returns shall have been received the usual annual report will be prepared containing in greater detail the final statistics as well as information relating to exploration, development, prices, markets, imports, and exports, etc:

I am, sir, your obedient servant,

(Signed) John McLeish.

Division of Mineral Resources and Statistics,
February 27, 1912.

PRELIMINARY REPORT ON THE MINERAL PRODUCTION OF CANADA, 1911.

(Statistics subject to revision.)

The mining industry during the years 1909 and 1910 showed such substantial progress and large increase in output that it is not surprising a slight falling off should be shown in 1911, particularly when it is remembered that the long continued strike of coal miners in Alberta and the Crowsnest district of British Columbia not only seriously reduced the coal output, but also, because of the closing down of the Granby smelter on account of the coke shortage, caused a lower production of copper, silver, and gold than would have otherwise been obtained.

The preliminary statistics herewith published, based upon direct returns from mine and smelter operators but subject to final revision, show the total value of the production in 1911 to have been $102,291,686, a falling off of $4,531,937, or 4 per cent, when compared with the production of $106,823,623 in 1910.

The production of the more important metals and minerals is shown in the following tabulated statement in which the figures are given for the two years, 1910 and 1911, in comparative form, and the increase or decrease in value shown. Tabulated statements for both years, in greater detail, will be found on subsequent pages of this pamphlet:—

	1910.		1911.		Increase (+) or decrease (−) in value.
	Quantity.	Value.	Quantity.	Value.	
		$		$	$
Copper....................Lbs.	55,692,369	7,094,094	55,848,665	6,911,831	182,263
Gold....................Ozs.	493,707	10,205,835	....	9,762,096	443,739
Pig iron....................Tons	800,797	11,245,622	917,535	12,306,860	− 1,061,238
Lead....................Lbs.	32,987,508	1,216,249	23,525,050	818,672	− 397,577
Nickel....................„	37,271,033	11,181,310	34,098,744	10,229,623	− 951,687
Silver....................Ozs.	32,869,264	17,580,455	32,740,748	17,452,128	− 128,327
Other metallic products....................	.....	510,081	....	409,674	− 100,407
Total....................	.....	59,033,646	....	57,890,884	− 1,142,762
Less pig iron credited to imported ores.	695,891	9,594,773	875,349	11,693,456	− 2,098,683
Total metallic....................	.....	49,438,873	....	46,197,428	− 3,241,445
Asbestos and asbestic....................Tons	102,215	2,573,603	126,914	2,943,107	− 369,504
Coal....................„	12,909,152	30,909,779	11,291,553	26,378,477	− 4,531,302
Gypsum....................„	525,246	934,446	505,457	978,863	− 44,417
Natural gas....................	.....	1,346,471	....	1,820,923	− 474,452
Petroleum....................Bls.	315,895	388,550	291,092	357,073	31,477
Salt....................Tons.	84,092	409,624	91,582	443,004	+ 33,380
Cement....................Bls.	4,753,975	6,412,215	5,635,950	7,571,299	− 1,159,084
Clay products....................	.....	7,629,956	....	8,317,709	− 687,753
Lime....................Bus.	5,848,146	1,137,079	7,227,310	1,493,119	+ 356,040
Stone....................	.....	3,650,019	....	3,680,371	+ 30,352
Miscellaneous non-metallic....................	.....	1,993,008	....	2,110,313	+ 117,305
Total non-metallic....................		57,384,750	....	56,094,258	− 1,290,492
Grand total....................		106,823,623	....	102,291,686	− 4,531,937

The subdivision of the mineral production in 1910 and 1911 by provinces was approximately as follows:—

Provinces.	1910.		1911.	
	Value of Production.	Per cent of Total.	Value of Production.	Per cent of Total.
	$		$	
Nova Scotia....................	14,195,730	13·29	15,354,928	15·01
New Brunswick....................	581,942	0·54	611,597	0·60
Quebec....................	8,270,136	7·74	9,087,698	8·88
Ontario....................	43,538,078	40·76	42,672,904	41·72
Manitoba....................	1,500,359	1·40	1,684,677	1·65
Saskatchewan....................	498,122	0·47	618,379	0·60
Alberta....................	8,996,210	8·42	6,404,110	6·26
British Columbia....................	24,478,572	22·92	21,237,801	20·76
North West Territories....................	4,764,474	4·46	4,619,592	4·52
Dominion....................	106,823,623	100·00	102,291,686	100·00

Of the total production in 1911 a value of $46,197,428 or 45 per cent is credited to metals and $56,094,258 to non-metallic products. Practically all of the metals with the exception of pig iron show a falling off in production in so far as value is concerned. In the case of copper, however, there was an increased output of the metal although the average price per pound was slightly lower than in 1910. The increase in pig iron production was quite considerable although this is chiefly attributable to imported ore.

Amongst the non-metallic products increases are shown in the production of arsenic, asbestos, feldspar, graphite, natural gas, pyrites, salt, and in nearly all of the structural materials, including cement, clay products, stone, lime, etc.

Outside of the metallic products the principal decreases are in coal and petroleum; the falling off in value of coal production alone being practically equivalent to the total net decrease for the year.

There is comparatively little change in the relative importance of the Provinces as mineral producers—Ontario contributed nearly 42 per cent of the total in 1911; British Columbia nearly 21 per cent; Nova Scotia 15 per cent; Quebec nearly 9 per cent and Alberta 6 per cent. The order in 1910 was the same except that Alberta slightly exceeded Quebec in production.

The Provinces showing an increased output for the year are Nova Scotia, New Brunswick, Quebec, Manitoba, and Saskatchewan; those showing a falling off being Ontario, Alberta, and British Columbia.

In Nova Scotia the coal industry was particularly active and to that and the clay and stone industries is the increase in this Province to be chiefly ascribed. There was a slight increase in New Brunswick. In Ontario the net result was a decrease of about $1,000,000, being chiefly in copper, nickel, and petroleum; on the other hand there were substantial increases in nearly all of the other products of which a great variety is obtained in this Province. Manitoba produces gypsum, clay, and stone products; and Saskatchewan coal and clays.

The difficulties incident to coal mining operations in Alberta and British Columbia have already been noted and these have been the chief cause of falling off in production in these Provinces. In British Columbia notwithstanding the coke shortage and the consequent closing down of the Granby smelter for a portion of the year there was still a slight increase in the copper production although the output of silver, lead, and zinc was less than in 1910.

THE MINERAL PRODUCTION OF CANADA IN 1911.

(Subject to revision.)

Product.		Quantity.	Value.
METALLIC.			$
Copper, value at 12·376 cents per pound	Lbs.	55,848,665	6,911,831
Gold			9,762,096
Pig iron from Canadian ore	Tons.	42,186	613,404
Iron ore sold for export	"	39,162	86,812
Lead, value at 3·48 cents per pound	Lbs.	23,525,050	818,672
Nickel, value at 30 cents per pound	"	34,098,744	10,229,623
Silver, value at 53·304 cents per oz	Ozs.	32,740,748	17,452,128
Cobalt and nickel oxides			221,790
Zinc ore		2,590	101,072
Total			46,197,428
NON METALLIC.			
Actinolite	Tons.	67	736
Arsenic, white	"	2,097	76,237
Asbestos	"	100,893	2,922,062
Asbestic	"	26,021	21.045
Chromite	"	27	351
Coal	"	11,291,553	26,378,477
Corundum	"	1,472	161,873
Feldspar	"	17,718	51,924
Fluorspar	"	34	258
Graphite	"	1,269	69,576
Grindstones	"	5,312	49,942
Gypsum	"	505,457	978,863
Manganese	"	54	300
Magnesite	"	991	5,531
Mica	"		119,863
Mineral pigments—			
Barytes	"	50	400
Ochres	"	3,622	28,333
Mineral water			223,758
Natural gas			1,820,923
Peat	Tons.	1,463	3,817
Petroleum, value at $1 22⅔ per barrel	Bls.	291,092	357,073
Phosphate	Tons.	558	4,928
Pyrites	"	82,666	365,820
Quartz	"	60,526	83,865
Salt	"	91,582	443,004
Talc	"	7,300	22,100
Tripolite	"	20	122
Total			34,191,161

THE MINERAL PRODUCTION OF CANADA IN 1911—*Concluded.*

(Subject to revision.)

Product.		Quantity.	Value.
STRUCTURAL MATERIALS AND CLAY PRODUCTS.			$
Cement, Portland	Bls.	5,635,950	7,571,299
Clay products—			
Brick, common, pressed, paving			6,521,558
Sewer-pipe			799,756
Fireclay, drain tile, pottery, etc			996,395
Lime	Bus.	7,227,310	1,493,119
Sand and gravel (exports)	Tons.	573,494	408,110
Sand-lime brick			424,241
Slate	Sq.	1,833	8,248
Stone—			
Granite			880,309
Limestone			2,282,146
Marble			140,903
Sandstone			377,013
Total structural materials and clay products			21,903,097
All other non-metallic			34,191,161
Total value, metallic			46,197,428
Total value, 1911			102,291,686

The average monthly prices of the metals in cents per pound for several years past are shown herewith.

—	1907.	1908.	1909.	1910.	1911.
	Cts.	Cts.	Cts.	Cts.	Cts.
Copper, New York	20·004	13·208	12·982	12·738	12·376
Lead "	5·325	4·200	4·273	4·446	4·420
" London	4·143	2·935	2·839	2·807	3·035
" Montreal*					3·480
Nickel, New York	45·000	43·000	40·000	40·000	40·000
Silver "	65·327	52·864	51·503	53·486	53·304
Spelter "	5·962	4·720	5·503	5·520	5·758
Tin "	38·166	29·465	29·725	34·123	42·281

* Quotations furnished by Messrs. Thomas Robertson & Company, Montreal, Que.

Smelter Production.

General statistics of smelter production have been collected by this Branch since 1908. Complete returns have been received for the year 1911 with the exception of one or two plants recently established for the treatment of Ontario silver cobalt ores. It should also be explained that the accompanying statistics include the treatment of a small quantity of imported ores in the British Columbia smelters.

The total quantity of ores treated in 1911 was 2,192,727 tons as compared with 2,683,714 tons treated in 1910.

The ores treated may be conveniently classified as follows:—

—	1909.	1910.	1911.
	Tons.	Tons.	Tons.
Nickel-copper ores	462,336	628,947	610,834
Silver-cobalt-nickel-arsenic ores	8,384	9,466	8,504
Lead and other ores treated in lead furnaces	54,539	57,549	55,408
Copper-gold-silver ores	1,850,889	1,987,752	1,517,981
Total	2,376,148	2,683,714	2,192,727

The closing down of the Granby smelter due to coke shortage was the principal cause of the falling off in copper-gold ores treated.

The products obtained in Canada from the treatment of these ores include: refined lead produced at Trail, B.C., and fine gold, fine silver, copper sulphate, and antimony produced from the residues of the lead refinery; silver bullion, white arsenic, nickel oxide, and cobalt oxide produced in Ontario from the Cobalt District ores. In addition to these refined products, blister copper, copper matte, and nickel copper matte are produced and exported for refining outside of Canada.

The aggregate results of these smelting and refining operations for the years 1910 and 1911 are briefly summarized in the following table:—

SMELTER AND REFINERY PRODUCTION IN CANADA, 1910 AND 1911.

—		1910.		1911.	
		Refined products.	Metals contained in matte, blister, and base bullion.	Refined products.	Metals contained in matte, blister, and base bullion.
Antimony	Lbs.	....	....	30	
Gold	Ozs.	13,298	197,181	15,270	175,189
Silver	"	16,373,799	2,136,414	17,711,077	612,401
Lead	Lbs.	32,987,508	....	23,525,050	
Copper	"	....	56,149,299	....	47,788,131
Copper sulphate	"	163,228	....	197,187	
Nickel	"	....	37,587,676	....	34,098,744
Cobalt and nickel oxides	"	13,508	....	15,174	
Mixed oxides of cobalt and nickel	"	108,178	....	127,224	
White arsenic	"	3,003,467	....	4,194,209	

Smelter products shipped outside of Canada for refining were: blister copper carrying gold and silver values 10,710 tons in 1911, as compared with 13,918 tons in 1910; copper matte carrying gold and silver values 11,320 tons in 1911, as against 11,519 tons in 1910; Bessemer nickel copper matte carrying small gold and silver values as well as metals of the platinum group 32,607 tons in 1911, as compared with 35,033 tons in 1910.

Gold.

The gold production in 1911 is estimated as approximately $9,762,096 which, compared with the 1910 production $10,205,835, shows a falling off of $443,739. The Yukon placer production in 1911 is estimated at $4,580,000 as against $4,550,000 in 1910, the total exports on which royalty was paid during the calender year, according to the records of the Interior Department, being 277,430·97 ounces in 1911 and 275,472·51 ounces in 1910. The British Columbia production in 1911 was $4,989,524, of which the placer production, as estimated by the Provincial Mineralogist, was $468,000, smelter recoveries and bullion obtained from milling ores being valued at $4,521,524.

The production in Nova Scotia is estimated at $142,000, all from milling ores. In Quebec there was a small recovery from alluvial workings and a small content in the pyrite ores shipped, the total value of production being $12,443. Returns so far received from Ontario show a production of $37,929.

The exports of gold-bearing dust, nuggets, gold in ore, etc., in 1911 were valued at $7,493,523.

Gold was imported during 1911 in bars, blocks, ingots, etc., to the value of $924,233.

Silver.

The silver production of Canada which has been very rapidly increasing during the past few years will probably show but little change in 1911.

Returns so far received appear to indicate a falling off of about 128,516 ounces. The total production of the year is estimated at 32,740,748 ounces valued at $17,452,128, of which 30,761,690 ounces were from Ontario, 1,910,323 ounces from British Columbia, 50,300 ounces from the Yukon, and 18,435 ounces from Quebec.

The production in Ontario was slightly greater than that of the previous year and in British Columbia a falling off of nearly half a million ounces is shown.

For British Columbia the figures represent the recovery as silver bullion or silver contained in smelter products, while for Ontario the figures represent the total silver content of ore and concentrates shipped less five per cent allowed for smelter losses, together with bullion shipments.

The total shipments of ore and concentrates from the Cobalt district and adjacent mines were about 16,234 tons, containing approximately 28,817,198 ounces in addition, to which 3,334,052 ounces were shipped as bullion. The average silver content of ore and concentrates shipped was thus about 1,744 ounces or $929.62 per ton, as compared with an average of 867 ounces in 1910 and 840 ounces in 1909. The 1911 shipments were chiefly high grade ore averaging over 3,400 ounces and concentrates averaging over 850 ounces.

The shipments in 1910 were 28,684 tons of ore containing 23,797,111 ounces of silver or an average of 830 ounces per ton; 6,943 tons of concentrates containing 7,111,579 ounces or an average of 1,024 ounces per ton, and bullion containing 1,003,111 fine ounces.

The exports of silver in ore, etc., as reported by the Customs Department, were 31,216,725 ounces, valued at $15,807,366. There was also an importation of silver in bars, blocks, sheets, etc., valued at $847,645.

The price of refined silver in New York varied between a minimum of 51⅝ cents per ounce in February, and a maximum of 56⅝ cents in November, the average monthly price being 53·304 as compared with an average monthly price of 53·486 in 1910.

Copper.

There is practically no production of refined copper in Canada, and the production is represented by the copper content of smelter products, matte, and blister copper produced, together with the amount of copper contained in ores exported estimated as recoverable.

The total production on this basis in 1911 was 55,848,665 pounds, valued at $6,911,831, as compared with 55,692,369 pounds valued at $7,094,094 in 1910, an increase in quantity of 156,296 pounds, but a falling off in total value owing to the slightly lower price of copper in 1911.

The total copper content of ores shipped in 1911 was approximately 67,282,590 pounds, being 3,123,189 pounds from Quebec, 21,402,221 pounds from Ontario, and 42,757,180 pounds from British Columbia. This record is of special interest as illustrating the distinction between ore content and smelter recoveries.

Of the production or smelter recovery in 1911, Quebec Province is credited with 2,436,190 pounds as against 877,347 pounds in 1910. This is altogether from pyrite ores, which are mined primarily for their sulphur contents. Ontario's production in 1911 was 17,932,263 pounds, as compared with 19,259,016 pounds in 1910, all being from the nickel-copper ores of the Sudbury district.

The production in British Columbia, notwithstanding the failure of the domestic coke supply due to strikes in the coal mines of the Crowsnest Pass district and the consequent shutting down of the Granby smelter for nearly five months, shows a slight increase, being estimated at 35,480.212 pounds in 1911 as against 35,270,006 pounds in 1910.

The British Columbia Copper Company operated with larger output, using imported coke and production from Coast mines, particularly the Britannia and Marble Bay, was specially active. The increased production from these mines more than balanced the falling off at Granby.

The New York price of electrolytic copper varied during the year between the limits of 11·85 cents and 14·05 cents per pound, the average being 12·376. During December the price ranged from 13 to 14 cents. The average monthly price in 1910 was 12·738 cents.

The total exports of copper contained in ore, matte, and blister, etc., according to Customs Department returns, were 55,287,710 pounds, valued at $5,467,725, which agrees fairly closely with the record of production.

The total imports of copper in 1911 were valued at $4,936,459 and included crude and manufactured copper to the extent of 35,155,550 pounds valued at $4,632,452; copper sulphate 2,191,899 pounds, valued at $88,419, and other copper manufactures valued at $215,588.

Lead.

The total production of pig and manufactured lead in 1911 was 23,525,050 pounds, valued at $818,672 or an average of 3·48 cents per pound, the average wholesale or producer's price of pig lead in Montreal for the year. There was also a small production of lead concentrate from Calumet Island, Que., the shipments being about 45 tons.

The production of lead in 1910 was 32,987,508 pounds, thus showing a considerable falling off in 1911. The decrease is probably chiefly due to the diminished ton-

nage from the St. Eugene mine in East Kootenay and the idleness of some of the more important mines of the Slocan following the destruction of the Kaslo and Slocan railway by forest fires in 1910. The Bear Lake branch of the Canadian Pacific railway now under construction will provide shipment facilities for these properties.

The Sandon and Silverton camps would seem to promise an increased tonnage of silver-lead ores in the near future.

The exports of lead in ore in 1911 are reported as 32 tons and of pig lead only 36 tons, as compared with exports of 23 tons and 3,856 tons respectively in 1910.

The total value of the imports of lead and lead products in 1911 was $1,049,276 including 13,135 tons in the form of pig lead, bars, sheets, tea lead, etc., valued at $706,020; manufactures of lead, valued at $108,012; litharge and lead pigments having an equivalent lead content of approximately 2,395 tons, valued at $235,244.

The total value of the imports of lead and lead products in 1910 was $833,743 and with the exception of manufactures, valued at $107,688, represented an equivalent lead content of 10,544 tons.

The average monthly price of lead in Montreal during 1911 was 3·48 cents per pound and in Toronto 3·53 cents. These are producer's prices for lead in car lots as per quotations kindly furnished by Messrs. Thos. Robertson & Company. The average monthly price of lead in New York during the year was 4·42 cents and in London £13·970 per long ton, equivalent to 3·035 cents per pound.

The amount of bounty paid during the twelve months ending December 31, 1911, on account of lead production, was $219,557.70, as compared with payments of $318,308.28 in 1910.

Nickel.

The mining and smelting of nickel copper ores in the Sudbury district of Ontario was carried on actively throughout the year, and although the production was slightly less than in 1910, it was still very much larger than in any previous year. Active operations were as usual carried on by the Mond Nickel Company at Victoria mines and the Canadian Copper Company at Copper Cliff, Creighton, Crean Hill, etc., while the Dominion Nickel Company continued to develop their property at Norman station.

The ore is first roasted and then smelted and converted to a Bessemer matte containing from 77 to 82 per cent of the combined metals, copper and nickel, the matte being shipped to the United States and Great Britain for refining. A portion of the matte is now used for the production of the alloy monel metal which is obtained directly from the matte without the intermediate refining of either nickel or copper.

The total production of matte in 1911 was 32,607 tons, valued at the smelters at $4,945,593, a decrease of 2,426 tons or 6·9 per cent from the production of 1910. The metallic contents were, copper 17,932,263 pounds, and nickel, 34,008,744 pounds.

The aggregate results of the operations on the Sudbury District nickel-copper ores during the past four years were as follows in tons of 2,000 pounds:—

	1908.	1909.	1910.	1911.
Ore mined	409,551	451,892	652,392	612,511
" smelted	360,180	462,336	628,947	610,834
Bessemer matte produced	21,197	25,845	35,033	32,607
Copper content of matte	7,503	7,873	9,630	8,966
Nickle " "	9,572	13,141	18,625	17,049
Spot value of matte shipped	$2,930,989	$3,913,017	$5,380,064	$4,945,592
	Pounds.	Pounds.	Pounds.	Pounds.
Exports to Great Britain	2,554,486	3,843,763	5,335,331	5,023,393
" United States	16,865,407	21,772,635	30,679,451	27,596,578
	19,419,893	25,616,398	36,014,782	32,619,971

The price of refined nickel in New York remained practically constant throughout the year—quotations in the *Engineering and Mining Journal* being large lots, contract business, 40 to 45 cents per pound during the first four months and 40 to 50 cents from May to December. Retail spot from 50 cents for 500 pound lots up to 55 cents for 200 pound lots. The price for electrolytic is 5 cents higher.

The imports of nickel anodes in 1911 were valued at $34,199, as compared with $23,317 in 1910.

Iron.

Iron Ore.—The total shipments of iron ore in 1911 are reported as 210,344 tons, valued at $522,319. These may be classified as magnetite 72,945 tons, and hematite 137,399 tons.

In 1910 the total shipments were 259,418 tons comprising: magnetite 127,768 tons; hematite 130,380 tons, and bog ore 1,270 tons.

Exports of iron ore from Canada during 1911 are recorded by the Customs Department as 37,686 tons, valued at $133,411. The exports were chiefly from Bathurst, New Brunswick.

The shipments from the Wabana mines, Newfoundland, in 1911, by the two Canadian companies operating there, were 1,181,463 short tons, of which 765,184 tons were shipped to Sydney and 416,279 tons to the United States and Europe.

Pig Iron.—The total production of pig iron in Canadian blast furnaces in 1911 was 917,535 tons of 2,000 pounds, valued at approximately $12,306,860, as compared with 800,797 tons, valued at $11,245,622, in 1910.

Of the total output in 1911, 20,758 tons were made with charcoal as fuel and 896,777 tons with coke. The classification of the production according to the purpose for which it was intended was as follows:—

Bessemer, 208,626 tons; basic, 464,220 tons; foundry and miscellaneous, 244,686 tons.

The amount of Canadian ore used during 1911 was 67,434 tons; imported ore, 1,628,368 tons; mill cinder, etc., 30,298 tons.

The amount of coke used during the year was 1,121,321 tons, comprising 543,933 tons from Canadian coal and 577,388 tons imported coke or coke made from imported coal. There were also used 1,190,459 bushels of charcoal.

Limestone flux was used to the extent of 625,216 tons.

In connexion with blast furnace operations there were employed 1,778 men, and $1,097,355 were paid in wages.

The total daily capacity of 18 completed furnaces was according to returns received 3,630 tons, and the number of furnaces in blast December 31, 1911, was 12.

The production of pig iron by Provinces in 1910 and 1911 was as follows:—

PRODUCTION OF PIG IRON BY PROVINCES, 1910 AND 1911.

Provinces	1910.			1911.		
	Tons.	Value.	Value per Ton.	Tons.	Value.	Value per Ton.
		$	$		$	$
Nova Scotia	350,287	4,203,444	12 00	390,242	4,682,904	12 00
Quebec	3,237	85,255	26 34	658	17,282	26 31
Ontario	447,273	6,956,923	15 55	526,635	7,606,674	14 44
Total	800,797	11,245,622	14 04	917,535	12,306,860	13 41

The exports of pig iron during the year are reported as 5,870 tons, valued at $271,968, an average of $46.33 per ton. Probably the greater part of this is ferro-silicon and ferro-phosphorus, produced at Welland and Buckingham, respectively.

There were imported during the year 208,487 tons of pig iron, valued at $2,610,989, and 17,226 tons of ferro-manganese, etc., valued at $429,465.

Steel.—The production of steel ingots and castings in 1910 is reported as 876,215 tons of 2,000 pounds, of which 861,493 tons were ingots and 14,722 tons castings.

The production in 1910 was 822,284 tons, including 803,600 tons of ingots and 18,684 tons of castings.

The production of open-hearth and Bessemer steel has been for four years as follows:—

PRODUCTION OF STEEL, 1908, 1909, 1910, 1911.

—	1908.	1909.	1910.	1911.
	Tons.	Tons.	Tons.	Tons.
Ingots—Open-hearth (basic)	443,442	535,988	580,932	651,676
Bessemer (acid)	135,557	203,715	222,668	209,817
Castings—Open-hearth	9,051	14,013	18,085	13,982
Other steels	713	1,003	599	740
Total	588,763	754,719	822,284	876,215

Asbestos.

For a number of years past the annual output of asbestos has exceeded the sales. In 1911, however, the sales have been greatly increased but at considerably reduced prices. Returns received for the year 1911 show a total output of 96,299

tons, as compared with 100,430 tons in 1910. The sales in 1911 are, however, reported as 100,893 tons, valued at $2,922,062 or an average of $28.96 per ton, as compared with 77,508 tons valued at $2,555,974, or an average of $32.98 per ton in 1910, an increase of 23,385 tons or 30 per cent in quantity but only $366,088, or 14 per cent in total value. Stocks on hand at December 31, 1911, are reported as 34,568 tons, valued at $1,509,100, as compared with 41,903 tons, valued at $1,943,171, on December 31, 1910.

The average number of men employed in mines and mills during 1911, was 2,707 at a wage cost of $1,231,896.

The total quantity of asbestos rock sent to mills is reported as 1,484,691 tons, which, with a mill production of 91,237 tons, shows an average estimated recovery of about 6·14 per cent.

The following tabulated statement shows the output and sales during 1911 and the stock on hand at the end of the year:—

—	Output.	Sales.			Stock on hand. Dec. 31.	
	Tons.	Tons.	Value.	Per ton.	Tons.	Value.
			$	$		$
Crude No. 1	1,467·9	1,301·4	342,855	263 45	1,256	327,508
" 2	3,594·5	3,562·7	402,107	112 86	3,222·7	404,198
Mill stock No. 1	20,376	18,315	916,678	50 05	8,471	380,570
" 2	39,289	47,326	991,370	20 95	17,794	365,457
" 3	31,572	30,388	269,052	8 85	3,824	31,367
Total asbestos	96,299·4	100,893·1	2,922,062	28 96	34,567·7	1,509,100
Asbestic	.....	26,021	21,045	81	.....	

In the absence of a uniform classification of asbestos of different grades the above subdivisions have been adopted purely on a valuation basis: crude No. 1 comprising material valued at $200 and upwards, and crude No. 2 under $200; mill stock No. 1 includes stock valued at from $30 to $100; No. 2 from $15 to $30; No. 3 under $15.

Output, sales, and stocks in 1910 were as follows:—

—	Output.	Sales.			Stock on hand. Dec. 31.	
	Tons.	Tons.	Value.	Per ton.	Tons.	Value.
			$	$		$
Crude No. 1	2,181	1,817	471,675	259 58	1,702	446,675
" 2	3,268	1,923	192,833	100 28	3,219	440,571
Mill stock No. 1	16,720	13,480	735,244	54 54	6,978	398,895
" 2	56,395	43,414	1,013,251	23 34	26,613	628,528
" 3	21,866	16,874	142,971	8 47	3.391	29,177
Total asbestos	100,430	77,508	2,555,974	32 98	41,903	1,943,846
Asbestic	...	24,707	17,629	0 71	.....	

Exports of asbestos during the twelve months ending December 31, 1911, are reported by the Customs Department as 75,120 tons, valued at $2,067,259, comprising: 62,551 tons, valued at $1,732,541, to the United States; 7,511 tons, valued at $192,993,

to Great Britain; 1,841 tons, valued at $62,737, to Belgium; 2,596 tons, valued at $52,047, to France; 361 tons, valued at $20,494, to Germany; and 260 tons, valued at $6,447, to other countries.

The imports of manufactures of asbestos during the same period are reported as valued at $319,815.

Coal and Coke.

The long continued strike which took place in the coal mines of southern Alberta and eastern British Columbia, was responsible for a considerable falling off in the coal production of Canada in 1911.

The total coal production during the past year, comprising sales and shipments, colliery consumption, and coal used in making coke, is estimated at 11,291,553 tons of 2,000 pounds, valued at $26,378,477. This is a decrease of 1,617,599 tons or nearly 12·53 per cent from the production of 1910, which was 12,909,152 tons, valued at $30,909,779.

There was an increase of 562,978 tons in the Nova Scotia production, that of New Brunswick remained practically stationery, while an increase of about 23,097 tons is shown in Saskatchewan.

In Alberta, the decrease was about 1,396,412 tons or 48 per cent, and British Columbia also shows a falling off of 794,243 tons or nearly 24 per cent.

The production by provinces was approximately as follows, the figures for 1909 and 1910 being also given:—

Province.	1909.		1910.		1911.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$
Nova Scotia	5,652,089	11,354,643	6,431,142	12,919,705	6,994,120	14,050,687
British Columbia	2,606,127	8,144,147	3,330,745	10,408,580	2,536,502	7,926,569
Alberta	1,994,741	4,838,109	2,894,469	7,065,736	1,498,057	3,933,958
Saskatchewan	192,125	296,339	181,156	293,923	204,253	342,921
New Brunswick	49,029	98,496	55,455	110,910	55,781	111,562
Yukon Territory	7,364	49,502	16,185	110,925	2,840	12,780
Total	10,501,475	24,781,236	12,909,152	30,909,779	11,291,553	26, 378,47

The exports of coal in 1911 were 1,500,639 tons, valued at $4,357,074, as compared with exports of 2,377,049 tons in 1910, valued at $6,077,350, a decrease in exports of 876,410 tons.

Imports of coal during the year include bituminous 8,905,815 tons, valued at $18,407,603; slack 1,632,500 tons, valued at $2,090,796, and anthracite 4,020,577 tons, valued at $18,794,192, or a total of 14,558,892 tons, valued at $39,292,591.

The imports of coal in 1910 were: bituminous, 5,966,466 tons; slack, 1,365,281 tons, and anthracite, 3,266,235 tons, or a total of 9,872,924 tons.

Coke.—The total production of oven coke in 1911 was 847,402 tons, valued at $2,340,674, as compared with the production of 902,715 tons, valued at $3,462,872, in 1910. The total quantity of coal charged to ovens was 1,228,700 short tons.

By provinces the production was: Nova Scotia, 469,305 tons; Ontario, 259,554 tons (made from imported coal); Alberta, 36,216 tons, and British Columbia, 82,327

tons. All the coke produced was used in Canada with the exception of 9,290 tons sold for export to the United States.

The quantity of coke imported during the calendar year was 751,389 tons, valued at $1,843,248, as compared with imports of 737,088 tons, valued at $1,908,725, in 1910.

Petroleum and Natural Gas.

A further falling off is shown in the output of petroleum, the production in 1911 being 291,092 barrels or 10,188,219 gallons, valued at $357,073, as compared with 315,895 barrels or 11,056,337 gallons, valued at $388,550, in 1910. The average price per barrel at Petrolia in 1911 was $1.22⅔, and in 1910, $1.23.

These statistics of production have been furnished by the Trade and Commerce Department and represent the quantities of oil on which bounty was paid, the total payments being $152,823.29 in 1911 and $165,845.06 in 1910.

The production in Ontario by districts as furnished by the Supervisor of Petroleum Bounties was, in 1911, as follows, in barrels: Lambton, 184,459; Tilbury and Romney, 48,708; Bothwell, 35,244; Dutton, 6,732; and Onondaga, 13,591. In 1910 the production by districts was: Lambton, 205,456; Tilbury and Romney, 63,058; Bothwell, 36,998; Leamington, 141; Dutton, 7,752; and Onondaga, 1,005.

The production in New Brunswick in 1911 was 2,461 barrels, as against 1,485 barrels in 1910.

Exports of refined oil in 1911 were 489 gallons, valued at $73. There was also an export of naphtha and gasoline of 23,959 gallons, valued at $4,427.

The imports of petroleum and petroleum products again show a very large increase. The total imports of petroleum oils, crude and refined, in 1911, were 116,892,689 gallons, valued at $6,009,739, in addition to 1,959,787 pounds of wax and candles, valued at $106,424. The oil imports included crude oil 71,637,533 gallons, valued at $2,187,952; refined and illuminating oils 13,690,962 gallons, valued at $722,403; gasoline 23,338,773 gallons, valued at $1,976,052 lubricating oils 5,308,917 gallons, valued at $806,452; and other petroleum products 2,916,504 gallons, valued at $316,891.

The total imports in 1910 were 84,629,334 gallons of petroleum oils, crude and refined, valued at $4,826,763, and 1,362,235 pounds of wax and candles, valued at $80,106.

A large increase is shown in the production of natural gas in 1911, the total value being reported as $1,820,923, of which $96,665 was the production in Alberta and $1,724,258 in Ontario. These values represent as closely as can be ascertained the value received by the owners of the wells for gas produced and sold or used and do not necessarily represent what the consumers have to pay for the gas, since in many cases the gas is resold once or twice by pipe line companies before reaching the consumer.

The total quantity of gas used in Ontario was about 9,869 million feet and in Alberta probably over 611 million feet.

The production of natural gas in 1910 was valued at $1,346,471, and represented about 7,952 million feet.

Cement.

Complete statistics have been received from the manufacturers of cement covering their production and shipments during the year 1911. These returns show that the total quantity of cement made during the year, including both Portland and slag cement, was 5,677,539 barrels, as compared with 4,396,282 barrels in 1910, an increase of 1,281,257 barrels, or 29 per cent.

The total quantity of Canadian Portland cement sold during the year was 5,635,950 barrels, as compared with 4,753,975 barrels in 1910, an increase of 881,975 barrels, or 18·5 per cent.

The total consumption of Portland cement in 1911, including Canadian and imported cement and neglecting an export of Canadian cement, valued at $4,067, was 6,297,866 barrels, as compared with 5,103,285 barrels in 1910, or an increase of 1,194,581 barrels, or 23·4 per cent.

Detailed statistics of production during the past four years are shown as follows:—

—	1908.	1909.	1910.	1911.
	Barrels.	Barrels.	Barrels.	Barrels.
Portland cement sold	2,665,289	4,067,709	4,753,975	5,635,950
" manufactured	3,495,961	4,146,708	4,396,282	5,677,539
Stock on hand January 1	383,349	1,098,239	1,189,731	844,741
" December 31	1,214,021	1,177,238	832,038	903,590
Value of cement sold	$3,709,063	$5,345,802	$6,412,215	$7,571,299
Wages paid	$1,275,638	$1,266,128	$1,409,715	$2,103,838
Men employed	3,029	2,498	2,220	3,010

The average price per barrel at the works in both 1910 and 1911 was $1.34, as compared with an average price of $1.31 in 1909 and $1.39 in 1908.

The imports of Portland cement during the twelve months ending December 31, 1911, were 2,316,707 cwt., valued at $834,879. This is equivalent to 661,916 barrels of 350 pounds at an average price per barrel of $1.26. The imports in 1910 were 349,310 barrels, valued at $468,046, or an average price per barrel of $1.34.

The imports from Great Britain during 1911 were 190,506 barrels, valued at $210,839; from the United States 441,317 barrels, valued at $575,768; from Belgium 2,683 barrels, valued at $2,019; from Hong Kong 22,059 barrels, valued at $38,292; and from other countries 5,351 barrels, valued at $7,962.

Following is an estimate of the Canadian consumption of Portland cement for the past five years:—

Calendar Years.	Canadian.		Imported.		Total.
	Barrels.	Per cent.	Barrels.	Per cent.	Barrels.
1907	2,436,093	78	672,630	22	3,108,723
1908	2,665,289	85	469,049	15	3,134,338
1909	4,067,709	97	142,194	3	4,209,903
1910	4,753,975	93	349,310	7	5,103,285
1911	5,635,950	89·5	661,916	10·5	6,297,866

EXPORTS OF PRODUCTS OF THE MINE AND MANUFACTURES OF MINE PRODUCTS, YEAR 1911.

(Compiled from Trade and Navigation Monthly Statements.)

Products.		Quantity.	Value.
			$
Arsenic	Lbs.	1,125,558	81,761
Asbestos	Tons	75,120	2,067,259
Coal	"	1,500,639	4,357,074
Feldspar	"	16,150	56,085
Gold			7,493,523
Gypsum	Tons.	362,102	425,161
Copper, fine in ore, etc	Lbs.	55,208,054	5,459,770
" black or coarse and in pigs	"	79,656	7,955
Lead, in ore, etc	"	65,100	1,826
" pig, etc	"	71,961	2,806
Nickel, in ore, etc	"	32,619,971	3,676,396
Platinum	Ozs.	39	1,961
Silver	"	31,216,725	15,807,366
Mica	Lbs.	693,940	242,548
Mineral pigments	"	3,999,925	27,070
Mineral water	Gals.	26,495	12,952
Oil, refined	"	489	73
Ores—			
Antimony	Tons.	57	4,946
Corundum	"	742	77,777
Iron	"	37,686	133,411
Manganese	"	4	225
Other ores	"	6,919	375,695
Phosphate	"	3	100
Plumbago	Cwt.	16,263	43,249
Pyrites	Tons.	32,102	120,585
Salt	Lbs.	454,600	5,055
Sand and gravel	Tons.	573,494	408,110
Stone, ornamental	"	168	1,796
" building	"	83,767	25,103
" for manufacture of grindstones	"	15	22
Other products of the mine			204,028
Total mine products			41,121,688
Manufactures—			
Agricultural implements—			
Mowing machines	No.	22,859	778,274
Reapers	"	9,385	574,315
Harvesters	"	14,355	1,432,911
Ploughs	"	20,437	508,095
Harrows	"	5,412	95,904
Hay rakes	"	11,085	317,842
Seeders	"	174	13,795
Threshing machines	"	339	92,442
Cultivators	"	5,923	138,377
All other			1,533,728
Parts of			796,246
Bricks	M	394	3,977
Cement			4,067
Clay, manufactures of			2,071
Coke	Tons.	9,852	39,823
Acetate of lime	Lbs.	7,428,157	117,904
Calcium carbide	"	4,888,975	142,402
Phosphorus	"	524,370	76,608
Earthenware and all manufactures of			6,101
Grindstones, manufactured			29,184
Gypsum and plaster ground			4,429
Iron and steel—			
Stoves	No.	1,176	20,626
Gas buoys and parts of			68,485
Castings, N.E.S			33,441
Pig iron	Tons.	5,870	271,968

EXPORTS OF PRODUCTS OF THE MINE AND MANUFACTURES OF MINE PRODUCTS, YEAR 1911—*Concluded.*

(Compiled from Trade and Navigation Monthly Statements.)

Products.		Quantity.	Value.
			$
Iron and steel — *Concluded.*			
Machinery (Linotype machines			12,239
" N.E.S.			431,493
Sewing machines	No.	18,519	218,075
Typewriters	"	4,771	318,935
Scrap iron and steel	Cwt.	84,153	54,618
Hardware, tools, etc			94,513
" N.E.S.			44,199
Steel and manufactures of			769,692
Lime			39,536
Aluminium in bars	Cwt.	49,901	747,587
" Manufactures of			1,555
Metals, N.O.P.			175,716
Naptha and gasoline	Gals.	23,959	4,427
Plumbago, manufactures of			33,956
Stone, ornamental			980
" building			456
Tar			56,669
Tin, manufactures of			30,176
Automobiles	No.	1,509	1,184,506
" parts of			45,798
Bicycles	No.	90	5,936
" parts of			50,828
Total manufactures			11,424,905
Grand Total			52,546,593

ANNUAL MINERAL PRODUCTION IN CANADA SINCE 1886.

Year.	Value of Production.	Value per Capita.	Year.	Value of Production.	Value per Capita.
	$	$ cts.		$	$ cts.
1886	10,221,255	2 23	1899	49,234,005	9 27
1887	10,321,331	2 23	1900	64,420,877	12 04
1888	12,518,894	2 67	1901	65,797,911	12 16
1889	14,013,113	2 96	1902	63,231,836	11 36
1890	16,763,353	3 50	1903	61,740,513	10 83
1891	18,976,616	3 92	1904	60,082,771	10 27
1892	16,623,415	3 39	1905	69,078,999	11 49
1893	20,035,082	4 04	1906	79,286,697	12 81
1894	19,931,158	3 98	1907	86,865,202	13 75
1895	20,505,917	4 05	1908	85,557,101	13 16
1896	22,474,256	4 38	1909	91,831,441	13 70
1897	28,485,023	5 49	1910	106,823,623	14 93
1898	38,412,431	7 32	1911	102,291,686	14 20

THE MINERAL PRODUCTION OF CANADA IN 1910.

(Revised.)

No.	Product.		1910. Quantity.	1910. Value. (a).	1910. Per cent of total.
	Metallic.			$	
1	Antimony ore	Tons*	364	13,906	
2	" refined	Lbs.	....	....	
3	Cobalt (i)	"	....	51,986	
4	Copper (b)	"	55,692,369	7,094,094	6·64
5	Gold	Ozs.	493,707	10,205,835	9·55
6	Pig iron from Canadian ore (c)	Tons.	104,906	1,650,849	1·54
7	Iron ore (exports)	"	114,449	324,185	0·30
8	Lead (d)	Lbs.	32,987,508	1,216,249	1·13
9	Nickel (e)	"	37,271,033	11,181,310	10·46
10	Silver (f)	Ozs.	32,869,264	17,580,455	16·45
11	Zinc ore	Tons.	5,063	120,003	0·11
	Total		....	49,438,873	46·28
	Non-Metallic.				
12	Actinolite	Tons.	30	330	
13	Arsenic	"	2,049	81,044	
14	Asbestos	"	77,508	2,555,974	2·39
15	Asbestic	"	24,707	17,629	
16	Chromite	"	299	3,734	
17	Coal	"	12,909,152	30,909,779	28·93
18	Corundum	"	1,870	198,680	0·18
19	Feldspar	"	15,809	47,667	
20	Fluorspar	"	2	15	
21	Graphite	"	1,392	74,087	
22	" artificial	"	1,221	....	
23	Grindstones	"	3,973	47,196	
24	Gypsum	"	525,246	934,446	0·87
25	Magnesite	"	323	2,160	
26	Mica	"	....	190,385	0·17
	Mineral pigments –				
27	Barytes	"	0	0	
28	Ochres	"	4,813	33,185	
29	Mineral water		....	199,563	0·18
30	Natural gas (g)		....	1,346,471	1·26
31	Peat	Tons.	841	2,664	
32	Petroleum (h)	Bls.	315,895	388,550	0·36
33	Phosphate	Tons.	1,478	12,578	
34	Pyrites	"	53,870	187,064	0·17
35	Quartz	"	88,205	91,951	
36	Salt	"	84,092	409,624	0·38
37	Talc	"	7,112	22,308	
38	Tripolite	"	22	134	
	Total		....	37,757,158	35·34

N.B.—Footnotes on p. 173.

THE MINERAL PRODUCTION OF CANADA IN 1910—*Concluded.*

(Revised.)

No.	Product.		1910. Quantity.	1910. Value. (*a*).	1910. Per cent of total.
	Structural Materials and Clay Products.			$	%
39	Cement, Portland	Bls.	4,753,975	6,412,215	6·00
	Clay products				
40	Brick, common	No.	627,715,319	5,105,354	4·77
41	Brick, pressed	"	67,895,034	807,284	0·75
42	Brick, paving	"	4,214,917	78,980	
43	Brick, moulded and ornamental		703,345	16,092	
44	Fireclay, and fireclay products			50,215	
45	Fireproofing and architectural terra-cotta			176,979	0·16
46	Pottery			250,924	0·23
47	Sewer-pipe			774,110	0·72
48	Tile, drain	No.	24,562,648	370,008	0·34
49	Lime	Bus.	5,848,146	1,137,079	1·06
50	Sand-lime brick	No.	44,593,541	371,857	0·34
51	Sand and gravel (exports)	Tons.	624,824	407,974	0·38
52	Slate	Squares.	3,959	18,492	
	Stone				
53	Granite			739,516	0·69
54	Limestone			2,249,576	2·10
55	Marble			158,779	0·14
56	Sandstone			502,148	0·47
	Total			19,627,592	18·37
	Grand total			106,823,623	100·00

* Short tons throughout.

(*a*) The metals copper, lead, nickel, and silver are for statistical and comparative purposes valued at the final average value of the refined metal. Pig iron is valued at the furnace, and non-metallic products at the mine or point of shipment.

(*b*) Copper content of smelter products and estimated recoveries from ores exported at 12·738 cents per pound.

(*c*) The total production of pig iron in Canada in 1910 was 800,797 tons valued at $11,245,622, of which 695,891 tons valued at $9,594,773 are credited to imported ores.

(*d*) Refined lead and lead contained in base bullion exported at 3·687 cents in 1910, the average price in Toronto.

(*e*) Nickel content of matte produced valued at 30 cents. (Increasing quantities of nickel-copper matte are now being used in making monel metal which is sold at a price much below that of refined nickel). The value of the nickel contained in matte, as returned by the operators, was about 10 cents per pound.

(*f*) Estimated recoverable silver at 53·486 cents.

(*g*) Gross returns for sale of gas.

(*h*) Quantity on which bounty was paid and valued at $1.23.

(*i*) Value received by shippers of silver cobalt ores for cobalt content.

APPENDIX II.

ON EXPLOSIVES.

(a)

INTRODUCTION.

In the Summary Report for 1910 there appeared an extended reference dealing with measures already initiated by the Mines Branch looking toward the establishment of Federal supervision over the manufacture, importation, transportation, storage, and testing of explosives in Canada.

It had been deemed advisable that, prior to taking definite action regarding so important a matter, the best possible expert advice should be obtained. Consequently, through the courtesy of the Home Office, Captain Arthur Desborough, H.M. Inspector of Explosives, was permitted to visit Canada and to act in an advisory capacity to the Dominion Government. In order to make himself thoroughly conversant with Canadian conditions, Capt. Desborough travelled throughout the country, inspected the various factories where explosives are manufactured, and finally submitted a report summing up his conclusions regarding the explosives industry of Canada. Subsequently a conference was held in the House of Commons at Ottawa on September 23 and 30, 1910. At this conference, which was attended by representatives of the Mines Branch and of the manufacturers of explosives throughout Canada, the practical effects that the proposed legislation would have on the explosives industry as at present established in this country, was thoroughly discussed with Captain Desborough himself.

Complete official statements relative to the Explosives Act have, therefore, been already issued by the Mines Branch. These statements have set forth, not only the complete text of the Explosives Act itself, but also the report by Captain Desborough and a complete account of the conference held at Ottawa to consider the proposed legislation. Considering, however, the wide-spread interest which the question has aroused among manufacturers and users of explosives throughout Canada, it has been deemed advisable to reproduce in the present publication not only the report of Captain Desborough, but also a statement of the various clauses of the Explosives Act itself.

Reprint.

REPORT ON THE EXPLOSIVES INDUSTRY IN THE DOMINION OF CANADA.

Captain Arthur Desborough, H.M., Inspector of Explosives.

OTTAWA, October, 1, 1910.

To Dr. EUGENE HAANEL,
Director of Mines, Ottawa.

SIR,—I have the honour to submit the following report on my investigation of the explosives industry in the Dominion of Canada.

Before offering any criticisms or recommendations, I propose to state briefly the more important principles upon which the British regulations are based; these general

principles being, in many cases, equally applicable to the regulation of the industry in the Dominion.

(1) *Authorization of Explosives.*—No explosive may be manufactured in or imported into the United Kingdom for sale until it has been subjected to examination by the chemical advisers of the Explosives Department. It is the duty of these gentlemen to satisfy themselves that the explosive is not unduly sensitive to friction or percussion, and that it also possesses a reasonable degree of chemical stability. Explosives which are found to be of the requisite standard are included in the list of authorized explosives as soon as a license is obtained to allow of their being manufactured or imported.

(2) *Manufacture of Explosives.*—No explosives may be manufactured except in an authorized place. A person, therefore, who wishes to manufacture explosives has to obtain a license. By the terms of his license he is only permitted to erect buildings of a specified construction, on the sites shown on a plan attached to his license. The maximum number of work-persons, and the maximum quantity of explosives allowed to be present in each building are specified, as is also the nature of the operations proposed to be carried on in the buildings. The factory buildings are required to be at certain distances from one another, and certain distances must also be observed from buildings and works outside the factory. The distances are determined by the quantity of explosives allowed to be present in the building. A table showing quantities of explosives and distances was drawn up some years ago from data obtained by noting the damage caused by explosions of known quantities of explosive; suitable interpolations were made to render the application of the table practical. Since the adoption of this system of distances, no member of the general public has been killed, and no dwelling house has sustained any serious structural damage by an explosion in any factory. From recent explosions it appears that the distances are hardly adequate where the explosive involved consists of nitro-glycerine unmixed with other ingredients.

Generally speaking, the buildings in which operations of manufacture are carried out are required to be of light construction, having close joined wooden floors and being lined with wood or other suitable material. I will refer to magazine construction under the head of storage.

No responsibility is taken by the Explosives Department regarding the machinery employed, but in the event of any particular type of machine proving to be dangerous, the question of its discontinuance is taken up with the occupier of the factory.

The maximum number of work people allowed to be present in a building is determined by the nature of the operations carried out in the particular building, and, as a rule, varies from two to six. This number is exclusive of the men employed to convey explosives or ingredients to or from the building and who are essentially non-producers.

I may add that the death rate among the employes has been for a considerable number of years well below 1 per 1,000.

Storage of Explosives.—Magazine licenses are issued by the Home Office for the storage of explosives. As in the case of factory licenses, the terms require that the building should maintain certain distances from the buildings and works depending on the quantity of explosives allowed to be kept. Only half the specified distance need be maintained if the building is screened by substantial earth banks, and if satisfactory screening is afforded by the natural features of the ground the distances are sometimes diminished by 75 per cent. Magazines are almost invariably constructed of substantial masonry or brickwork, as it is considered that if the explosive is of good quality the only dangers to be feared are those which will arise from outside the building. The only objection to this form of construction is, that should an explosion

occur in a building not surrounded by earth banks considerable damage may be caused by the projection of heavy debris. In the past thirty years, three magazines have been destroyed by explosions and in no case were any lives lost or surrounding property seriously damaged.

Licenses for the storage of limited quantities (2 tons of gunpowder or 1 ton of high explosive) are granted by the local authorities, if specified conditions as to construction and distances are observed.

Home Office Licenses.—Both factory and magazine licenses are prepared in draft by the applicant in consultation with the Explosives Department. When the draft has been agreed upon, the applicant is given permission by the Secretary of State to lay the draft before the local authority, in whose jurisdiction the proposed buildings are situated, in order to receive their assent. If the local authority give their assent, the draft license is confirmed. If, however, they refuse their assent, an inquiry is held by an officer of the Explosives Department, and the Secretary of State, on receipt of the report, either upholds the local authority or inserts additional terms to cover their objections, or over-rides their decision.

Transportation.—Accidents in transportation are practically unknown and this may be fairly ascribed to the quality of the explosives, the specified method of packing, and the care in handling the traffic. The method of packing and general regulations as to transportation are prescribed in Orders of Secretary of State made under the Act. Railway companies, canal companies, and harbour authorities have, however, to make by-laws regarding the transportation, loading, and unloading of explosives. These by-laws have to receive the sanction of the Board of Trade before they are operative.

Importation.—Only authorized explosives may be imported for sale. A person desiring to import explosives has to obtain an importation license from the Home Office. Before a license is granted he is required to show that he has an authorized place of storage at his disposal. Generally the importer owns licensed magazines, but if not he obtains a certificate from an occupier of a licensed magazine, that sufficient storage accommodation is available for the importation. When the importation is effected, the customs officers take samples which are forwarded for examination and the explosive is deposited in the specified magazines. If the samples are reported on as coming up to the required standard, the explosive is placed at the disposal of the importer. Otherwise, further samples are obtained (if the importer so desires), or the explosive is definitely condemned as being unfit for distribution. In certain doubtful cases the explosive is released, on the importer guaranteeing that it will all be used up in a limited time.

Use of Explosives.—The use of explosives is not governed by the Explosives Act. The use in mines and quarries is regulated by general rules contained in the Mines and Quarries Acts, and by special rules made under those Acts. A Bill was introduced into Parliament last year giving the Secretary of State power to make regulations regarding the use of explosives in construction works, but, owing to the large amount of other legislation before the House, the Bill was dropped.

Home Office Testing Station.—The station was established in 1897 under a section of the Coal Mines Regulation Act, 1896, and the work carried on there must not be confused with the purely chemical work of the chemical advisers of the Explosives Department. The station is used for testing explosives for use in coal mines where danger is to be feared from fire-damp or coal dust. The test consists in firing charges from a cannon into a chamber filled with an explosive atmosphere of air and coal gas.

The details of the test are about to be considerably modified and for this purpose a new apparatus is being erected in the north of England. Only authorized explosives may be submitted to the test and the names of those which have passed this test and the conditions under which they may be used are published from time to time in an Order of the Secretary of State. These explosives are known as Permitted Explosives.

Explosives Industry in the Dominion.

I have had the opportunity of visiting the majority of the more important factories. As was to be expected, the standard of precautionary measures against accidents varied considerably. Any criticism I may make must not be considered as being directed against any particular factory, as I purposely avoided making a detailed inspection of any one plant, feeling that with the very limited time at my disposal, the utmost I could do would be to obtain a general impression as to the conditions under which explosives were manufactured.

As regards the quality of the explosives, I will defer comment until I discuss the question of use, as the only information I have obtained was gained in course of conversation with the users of explosives.

Most of the factories appear to suffer from the defect of having been started in a small way and then added to as the business expanded. Had the probability of expansion been recognized at the commencement, there is little doubt but that the buildings would have been placed in more suitable positions and overcrowding thus avoided. In some instances the quantities in the buildings were considerably greater than the distances from other buildings would allow. This was sometimes due to the fact that explosive which had been operated on was allowed to remain in a building while a second batch was being operated on and a third was being brought into the building. As a general principle, a batch of explosives should be removed from a building as soon as it has been operated on; if the building in which the next operation is to take place is not available, it should be placed in an expense magazine situated at a suitable distance. The chief danger of explosion must of necessity be with the explosive which is being operated on; it is, therefore, unwise, to say the least of it, to expose a second or third batch to the certainty of communicated explosion. In other cases the excessive quantities were due to overcrowding of the factory buildings.

The actual operations of manufacturing nitro-glycerine appear to be generally carried out in one building, owing to climatic conditions, and this entails the accumulation of large quantities, sometimes amounting to over five tons, in one building. The majority of the factories have only one nitrating plant, and I think manufacturers should consider whether it would not be advisable to install a second plant, which could be used alternatively, and thus prevent such large accumulations in one building. An explosion in a nitrating plant must put a factory out of action for some considerable time, unless there is a duplicate plant available.

In some factories there were too many cartridge packing machines in one building. The objection to this practice does not lie in the number of machines but in the large number of men who must be present in the buildings to attend to the machines. In one instance, all the machines in the factory were under one roof, and no less than 15 men were present. Apart from humanitarian objections to the exposing of so many lives to one risk, I am strongly of opinion that it is economically unwise to concentrate all the cartridge packing in one building. I understand that in one factory last year 11 lives were lost, due to explosions which occurred in the packing house. This number exceeds the annual average number of deaths in all the explosives factories in Great Britain. Generally speaking, there appears to be a tendency to allow unnecessary articles to accumulate in danger buildings. The object of the manufacturer should be to reduce the number of movable implements to the minimum. When it

is remembered that a thin layer of most explosives can be exploded by a blow from a comparatively light weight falling a distance of a few feet, the importance of this point will be realized. I may mention in this connexion that I have more than once witnessed the experiment of a thin layer of gunpowder spread on a wooden floor being ignited by a glancing blow from a wooden broom stick.

The presence of iron hammers and other tools is also objectionable. When they are required, they should only be used by a responsible person and should be removed as soon as they are no longer wanted.

Greater care should be exercised to prevent grit getting into the explosive and also to prevent explosive from lodging in crevices in the walls and floors of buildings. The iron framework of machines should be painted to prevent the detachment of rust, which is otherwise almost certain to find its way into the explosive.

I do not think that manufacturers pay sufficient attention to details, and it is only by studying details that it is possible to make the manufacture of explosives relatively safe. Apart from the risk of spontaneous decomposition, which may arise on rare occasions during the manufacture of nitro-glycerine, there is the risk of spontaneous decomposition from explosive dust settling on heating pipes and being left there, and from accumulations of explosive in cracks and crevices. With reasonable precaution these latter risks should be practically non-existent. The heating pipes should be so placed that they are readily accessible to inspection and the walls should be lined with a suitable material; the floor, if not close joined, should also be covered. I understand that rubberoid has been employed both as a lining for the walls and a floor covering by several manufacturers, with excellent results.

Another risk to be guarded against is the ignition of a thin film of explosive by a blow. As I have already stated, as few movable articles as possible should be present in a building. When it is remembered that most explosives when heated are much more sensitive to friction or percussion, special precautions should be taken in drying houses to eliminate this risk, and I think that the explosive should be allowed to cool down to the normal temperature before it is handled or the drying racks removed.

Grit mixed with explosive renders it far more sensitive; precautions should, therefore, be taken to prevent its introduction either by the work persons themselves, or by its adhering to boxes and packages brought into the building. It is impossible to prevent a certain amount of grit entering a building, and this grit will, of necessity, be mostly present on the floors of the buildings; it is important, therefore, to minimize the quantity of explosive spilt on the floor and also to have the floors swept periodically.

In buildings in which explosion is likely to be preceded by fire it is especially necessary to provide adequate means of escape for the work people, and care should be taken that the exits are not blocked by boxes or packages.

Sufficient forethought does not seem to be paid to the wiring of the electric light system. Apart from the dangers of ordinary wear and tear, there is always the risk that the concussion caused by an explosion in a neighbouring building may so dislocate the wiring as to cause a fire.

Storage of Explosives.

I have not had the opportunity of visiting many magazines. In most instances the distances maintained from other buildings were inadequate, owing to the large quantities stored. I cannot help thinking that it would be wiser to erect a greater number of buildings and to store in each smaller quantities of from 25 to 50 tons.

In some instances I found packages of damaged explosive which had been returned by the users. Damaged explosive should be destroyed, as, if left in a magazine, it is liable to be overlooked and if of the nitro-compound class may ignite spontaneously.

Transportation of Explosives.

My attention was drawn to two instances of the transportation of explosives by water, which I think are deserving of comment. In one case, after over 100 tons of dynamite had been loaded into a vessel, a number of cans of gasoline were placed on top of the explosive. Highly inflammable and volatile liquids, such as gasoline, should not be transported with explosive. In another instance, cargoes of explosive were habitually conveyed in a gasoline launch. I do not think it can be claimed that gasoline launches have reached such a state of perfection that the possibility of fire can even be regarded as remote. If such a launch caught fire in a crowded harbour, the result would be disastrous.

Use of Explosives.

In the course of conversation with the users of explosives I have frequently been told that the quality of the explosives manufactured in the Dominion leaves much to be desired. It was asserted that no two charges fired in similar circumstances would do the same amount of work. Except so far as shot firing in coal mines is concerned, I do not think this unevenness of explosive can be said to be a positive danger, apart from the production of an unnecessarily large volume of deleterious gases from an over-charged shot. In the case of coal mines, where there is risk of igniting gas or dust, the danger is very appreciable. A miner will always gauge the weight of his charge by the weakest shot he has fired and the tendency will always be to overcharge. The gases produced from the surplus of explosive not having any work to do will not cool down rapidly, and should they come in contact with fire-damp or coal dust in suspension would probably cause an ignition. It is imperative, therefore, that steps should be taken to ensure an even quality of explosive for use in coal mines.

A thin film of explosive on the exterior of a cartridge, a state of affairs which I frequently noticed in the buildings in which cartridges were being packed into boxes, can hardly be conducive to safety in ramming. In the absence of specific information as to the accidents which occur from the use of explosives, I do not feel that it is possible for me to offer any further comments.

It will not be out of place, however, to give a word of warning as to the misleading effects of demonstrations of the safety of explosives. These experiments generally consist in burning a cartridge in the open or throwing a small quantity on to a fire. Such experiments can generally be performed with blasting explosives without risk. The behaviour of the explosive when confined in a bore hole or when ignited in bulk so that a certain amount of pressure is generated would be a much more reasonable test, but such experiments would not suit the demonstrator as they would be much more likely to result in an explosion. I may instance the case of many of the ammonium nitrate explosives, which are very difficult to ignite in the open, and when thrown on a red hot sheet of iron merely melt, but which in the confinement of a shot hole have been found, under certain conditions, to burn fairly readily until sufficient pressure is set up to cause the unburnt portion to explode.

It cannot be pressed too strongly upon the user of explosives that the function of an explosive is to explode, and that, no matter what assertions are made by an interested person as to the safety of his explosive, all explosives should be regarded as dangerous.

Recommendations.

In the following pages I have acted on the assumption that the Dominion Government has the power to legislate on these matters.

It is not possible for me to mention in detail all the points which I think should be included in the draft bill which is in course of preparation. I propose, therefore,

under the above heading, to discuss shortly some of the more important provisions which should be included in the proposed legislation and also to offer some suggestions on matters which, though they do not come directly within the scope of the bill, are of sufficient importance to warrant my commenting on them.

The following are the essential points which I propose to discuss:—

1. Authorization of explosives.
2. Licensing of factories.
3. Control of storage not otherwise provided for.
4. Control of transportation not otherwise provided for.
5. Control of importation.
6. Inspection and sampling.
7. Establishment of chemical laboratory and testing station.
8. Investigation of accidents in factories.
9. Investigation of accidents in storage, transportation, and use.
10. Appointment of staff.

(1) *Authorization of Explosives.*—I think the system in Great Britain should be adopted. It will undoubtedly improve the quality of the explosives manufactured in the Dominion and should thereby have a tendency to diminish accidents in use; it must not be expected, however, that fool-proof explosives will ever be produced. It will also prevent the user being at the mercy of the enthusiastic inventor who persuades him to try a new explosive which has probably been invented many years previously and then discarded on account of its danger or unsuitability.

(2) *Licensing of Factories.*—Factories should be licensed on the principle of limiting the amount of explosive allowed to be present in a building, in accordance with the distances that the building can maintain from the other buildings in the factory, and buildings and works outside the factory. Limitations should also be assigned as to types of construction adopted, the number of work persons allowed to be present, and the nature of the operations to be carried on in the various buildings. If these points are enforced in a reasonable manner, I do not think that manufacturers will find their trade unduly hampered.

As regards existing factories, I do not think the occupiers should be required to immediately conform to the new system, but that a definite time limit should be assigned, so as to admit of the change being made gradually. If, however, there happen to be particular buildings in a factory which constitute a very definite menace to the public safety by reason of their proximity to a city, I think the occupier should be required either to remove the building forthwith, or to reduce the quantity of explosive in the building, so as to diminish the danger zone. It is not possible to lay down a hard and fast rule and each case should be considered separately and treated on its merits.

(3) *Control of Storage.*—The special points to which attention should be paid are the situation, quantity of explosive, and construction. The first and second should be governed by the table of distances. As regards the third, two somewhat antagonistic features have to be considered. First, the building should be protected from dangers from without, such as rifle bullets, and should have security against unlawful entry and fire. Second, in the event of an explosion occurring the projection of heavy debris should be minimized; this feature is probably of greater importance in the Dominion than it is in Great Britain, owing to the fact of the large number of frame

dwelling houses which are to be found here, whilst they are almost non-existent in the latter country.

The ideal construction for a magazine would be to have a relatively lightly constructed building, surrounded by substantial earth banks, but it is difficult to make this type reasonably secure against unlawful entry and other dangers from without. It must always be remembered, however, that with the system of the authorization of explosives there should be little risk of the explosive igniting spontaneously, and as no operation should be carried on in a magazine the principal danger of explosion comes from causes outside the building. The results of some experiments carried out in Germany were recently published and the conclusion arrived at by the experimenters was, that a certain type of reinforced concrete gave the best result. It was found that with the particular form of construction very little debris was projected when an explosion occurred in the building, as the concrete was so pulverized that the fragments did not carry any great distance. If funds are available, it would be of considerable value to have experiments carried out on similar lines with buildings constructed to suit Canadian requirements.

In Great Britain there is a statutory requirement that every magazine should be fitted with an efficient lightning conductor; there are, however, no suggestions given as to what constitutes such a conductor. As I understand that parts of this country are frequently visited by severe electrical storms, I think the question of protecting magazines from lightning should be considered. I would venture to suggest that the scientific staff of some of the Universities and representatives of the explosives manufacturers should be invited to co-operate with your Department to inquire into the most efficient and economical system of securing the necessary protection. There is a system of storage in Great Britain, which I have not met with in the Dominion, but which might be found of use where the climatic conditions will admit of it. In the rivers Thames and Mersey vessels are moored at places specially selected by the Harbour Authorities, and these vessels are licensed by the Home Office as Magazines. Where there is a considerable water-borne trade, the use of such vessels as distributing centres might prove of advantage.

(4) *Control of Transportation.*—The control of transportation by rail is in the hands of the Railway Commissioners, and the only way in which the proposed legislation will affect this method of transportation will be as regards the quality of the explosive conveyed. I understand that the regulations adopted by the Commissioners are those promulgated by Col. Dunne's bureau in New York. The great value of these regulations has been amply proved, but being a private concern there are not the same facilities for maintaining the standards of quality of the explosives as will be the case when the authorization of explosives is in the hands of the Government.

I understand that at present it is practically impossible to transport legally small quantities of explosive by rail. It is generally certain that this traffic is carried on, probably in passenger trains, and with detonators and blasting explosive packed together. I would venture to suggest, therefore, that your Department should approach the Railway Commissioners, with a view to discussing the question of recognizing and controlling the transportation of small quantities. I may mention that in Great Britain the railway companies have agreed to transport small quantities of explosive in cars loaded with other freight, when packed in a special manner.

As regards transportation by water or road, I think power should be included in the bill to regulate generally the method of stowage, the method of packing, the limiting of the nature of freight which may be transported with explosives, and the limiting the quantity of explosive transported at any one time, according to the nature of the vessel or vehicle in which the transportation is being effected.

(5) *Importation.*—Before any explosive is imported into the Dominion for sale or use, a sample should be submitted for authorization. The terms of the license for

subsequent importations should require the importer to have at his disposal a licensed place of storage, in which the explosive would be detained until the chemical department have satisfied themselves by examination of the samples taken by the Customs that the explosive is of the requisite standard.

(6) *Inspection and Sampling.*—I need only remark that when a factory or magazine have been licensed it is necessary that they should be periodically inspected, to ascertain that the terms of the licenses are being complied with. Similarly, it is essential that after an explosive has once been authorized, samples should be periodically examined to see that the manufacturer is maintaining the required standard. Most explosives deteriorate in quality and chemical stability after prolonged storage. It is necessary, therefore, to obtain samples not only from factories and distributing magazines, but also from magazines in the occupation of the users of explosives. I have reason to believe that the Provincial authorities will be glad to co-operate with your Department in this respect.

(7) *Establishment of Testing Station.*—Apart from the chemical laboratory, which will be in the hands of the chemical advisers of the explosives department, it will be necessary to establish a station for the testing of explosives for use in coal mines. I understand that it is also considered desirable to erect an apparatus for testing types of safety lamps. I would suggest, however, that before deciding on the final details of the tests it would be well to await the conclusion of the experiments which are shortly to be carried out in Great Britain. It may be of interest to state that the Home Government have not contemplated instituting an official test for the so-called rescue apparatus. The word 'rescue' appears to give the general public the idea that after an explosion has occurred in a coal mine it is only necessary for men wearing these breathing apparatus to enter the mine, to enable them to rescue the unfortunate miners who have been exposed to the effects of the explosion and the deadly effect of after damp. I think the more reasonable view to hold as regards the practical utility of breathing apparatus is that their chief scope lies in the direction of coping with fires below ground in the early stages, and it is only in the sense of preventing the spread of a fire which would endanger the lives of those present in the mine that the term 'rescue' can be applied to them.

Apparatus should be installed at the testing station to enable comparisons to be made between the kinetic energy of different natures of explosives and also to determine the velocity of detonation of explosives. Information on these two points should prove of value to the users of explosives, to enable them to select the explosive most suitable for the work which they are undertaking.

(8) *Accidents in Explosives Factories.*—It is of the utmost importance that the explosives department should have full information regarding all accidents which occur in factories either by fire or explosion, even when no personal injuries are sustained. It is often from an accident in which no persons are injured that the most valuable information can be derived. I think that it should be obligatory for the occupiers of factories to report as soon as possible all such accidents, and to leave things untouched as far as is practicable, in case it should be deemed advisable to have the circumstances of the accident investigated by an official of the department.

(9) *Accidents in Storage, Transportation, and Use.*—Accidents which occur by fire or explosion in the storage and transportation of explosives should also be brought to the notice of the department; in those cases in which the storage or transportation comes under the control of the new Act, it may be desirable to have an inquiry held by an official of the department. In other cases, the co-operation of the Provincial Governments and the Railway Commissioners should be sought, in order to

obtain as complete a record as possible of such accidents. Doubtless, the Provincial Inspectors of mines will be willing to inform the new department of the results of their investigations. As regards accidents in transportation by rail, the services of an inspector of explosives should be placed at the disposal of the Railway Commissioners, should they so desire it, to assist in carrying out investigations.

By far the larger number of accidents which occur with explosives arise from their use; it is of the utmost importance that all accidents occurring when the explosives are in use should be thoroughly investigated and classified. I have reason to believe that the Provincial Inspectors of Mines will be willing to co-operate with the department by forwarding accounts of accidents occurring in the mines under their jurisdiction. I understand, however, that a large number of accidents occur in works where there is no legislation affecting the use of explosives. I think it would be advisable for the Minister of Mines to take power in the proposed bill to frame rules to regulate the storage and use of explosives in such works, to require the reporting of accidents, and to have investigations made when such a course appears necessary.

It may be of interest to summarize the causes of the more frequently occurring accidents which arise from the use of explosives in mines, quarries, and construction works in Great Britain.

1. *Prematures.*—Often due to the use of short or bad fuse, or the use of straws and squibs to ignite the charge. May arise from a man attempting to light too many shots and thus being unable to take cover.

2. *Hang-fires.*—Often due to irregular fuse, or the ignition of explosive, which burns until sufficient pressure is set up to cause it to explode; this may be due to inferior quality of explosive or a weak detonator. Sometimes due to miscounting shots and returning too soon.

3. *Electrical Prematures.*—Generally due to the shot firer allowing another man to connect the detonator leads to the firing cable, which has been previously attached to the battery.

4. *Ramming.*—Due to frozen nitro-glycerine explosive, broken cartridge leaving a thin film of explosive in the bore hole. Cartridge sticking in the bore hole and being violently forced home. It is of the utmost importance that no explosive which is unduly sensitive to friction or percussion should be authorized for use.

5. *Striking Unexploded Charge when Removing Debris.*—Generally due to frozen nitro-glycerine explosive, or to weak detonator which fails to cause propagation of detonation through all the cartridges, or to the cartridges becoming separated by a layer of dirt in the shot hole.

6. *Boring into a Missed Shot.*

7. *Tampering with a Missed Shot.*

8. *Not Taking Proper Cover.*—In the case of electrical firing generally due to use of too short a cable.

9. *Fumes.*—Either due to defective ventilation, men returning too soon, or ignition instead of detonation of high explosive. The gases evolved by burning nitro-glycerine explosives are very poisonous. The burning may be originated by weak detonator or inferior quality of explosive.

10. *Preparing Charges.*—Generally due to frozen nitro-glycerine explosive, unduly sensitive explosive, recklessness, or lack of skill.

11. *Ignition of Explosive by Spark.*—Principally confined to gunpowder, where open lights are used below ground.

12. *Socketting or Springing.*—Due to re-charging before sufficient time has elapsed.

13. *Ignition of Fire-damp or Coal Dust*—Apart from the quality of the explosive, generally due to the firing of two shots, one after the other, without examining for gas after firing the first shot. The firing of overcharged shots is perhaps the more usual cause.

It may be of interest to state that during 1909 over 30 million pounds of blasting explosives were used in mines, quarries, and construction works in Great Britain, and that (exclusive of fatalities from explosions of fire-damp or coal dust) 53 lives were lost thereby.

Staff of the Explosives Department.—The technical staff of the new department should, I think, consist of a Chief Inspector, two Inspectors, and a Chemist. I cannot state too emphatically that the Chief Inspector should have sufficient technical knowledge not only to enable him to administer what must of necessity be a very technical act, but also to deserve the confidence of the explosives manufacturers. As men possessing such qualifications are rare, I would venture to suggest that it would be very unwise to attempt to economize by offering an inadequate salary. As regards the two inspectors, it will hardly be possible to obtain the services of technically qualified gentlemen, and I think it would be sufficient if these gentlemen possessed practical experience of the use of explosives, one of them at least having gained his experience in coal mining. In assigning their salaries, the fact that their work must of necessity be somewhat hazardous should not be lost sight of.

The responsibility of the chemical adviser to the department will be considerable, as in his hands will rest the recommendation for the acceptance or rejection of explosives. When it is remembered that the authorization of an explosive or otherwise, or the condemnation of a batch of explosive which has been issued from a factory may involve large financial interests, it is hardly necessary for me to point out that this gentleman should be possessed of the highest technical qualifications and integrity. The salary of the chemical advisers of the Home Office is entirely dependent on fees, but it would be far preferable if the chemist of the new department were paid an adequate salary so that his whole time should be at the disposal of the government.

It will be necessary to employ a mechanic at the Testing Station, who will be competent to carry out minor repairs to the apparatus, and who would assist in carrying out official tests and experiments. He should also be responsible for the care of explosives stored in the magazine and for apparatus and stores used in connexion with the Testing Station.

I have the authority of Major Cooper Key, His Majesty's Inspector of Explosives, for stating that he will be glad to afford facilities for any person who may be appointed as an Inspector to be attached to the Explosives Department of the Home Office, to enable him to get an insight into the administration of the Explosives Act and the methods adopted for the testing of explosives for use in coal mines. Major Cooper Key also states that he would be glad to make arrangements for the chemical adviser of the new department to work in the laboratory of Messrs. Dupré, who are the chemical advisers of the explosives department. I would strongly urge that these facilities be taken advantage of.

If my proposal as to the regulation of the use of explosives be adopted, I would suggest that two or three gentlemen be appointed as assistant inspectors, whose duty

would be confined to the administering of these regulations. Their principal functions would be to endeavour to educate the users of explosives by means of lectures and practical demonstrations to avoid the misuse of explosives, and also to investigate any accidents which might occur.

I have the honour to be,

Sir,

your obedient servant,

(Signed) **A. Desborough**, Capt.

H. M. Inspector of Explosives.

MEMORANDUM.

Magazine Construction Committee.

The Committee should consist of a member of the Mines Department, a representative of the Militia Department, a representative of the Public Works Department, and two members of the explosives trade.

The object of the Committee would be to test different natures of construction by exploding from a half to one ton of explosive inside each building, and noting the distance to which the debris is projected.

The Committee should satisfy themselves that each building is reasonably secure against unlawful entry.

I would suggest that the explosive be invariably stacked at one end of the building, so as to leave as great an air space as possible from the other end. This point is especially important where the construction is of concrete.

The types of construction which might be experimented with are as follows:—

1. Expanded metal and cement plaster.
2. German special re-inforced concrete.
3. Log magazine.
4. Any type which the Committee suggest.

I think the attention of the Committee might be directed to the possibility of the expanded metal being carried above the roof, and also being grounded to form an economical system of protecting from lightning.

Transportation of Liquid Nitro-glycerine by Road.

Mr. Lowry, at the recent conference, raised this point with regard to the use of liquid nitro-glycerine in opening oil wells.

When nitro-glycerine was first used on a commercial scale, it was invariably transported in the liquid state. In consequence of the large number of accidents which occurred, the practice was prohibited in all European countries. Alfred Nobel then absorbed the liquid in an infusorial earth, solely with the view of rendering its transportation reasonably safe, and with the intention of extracting the nitro-glycerine by a process of displacement by water when it had been transported to the place at which it was required to be used. He found, however, that for ordinary blasting purposes it was not necessary to use the nitro-glycerine as a liquid, and he called the

plastic explosive dynamite. I have been told that it is essential to use liquid nitro-glycerine in opening oil wells, but I do not know if this practice is universal. If it is absolutely necessary to do so, I think that at any rate the nitro-glycerine should not be transported as a liquid but as dynamite. In Great Britain dynamite No. 1 is defined as a mixture of not more than 75 parts of nitro-glycerine absorbed in kieselgur.

A factory license could then be granted to allow of the nitro-glycerine being displaced in the immediate neighbourhood of where it was intended to be used; the operation to be effected in a definite building and to be under proper control and supervision.

Testing Station and Chemical Laboratory.

I attach to this paper a rough specification of the testing gallery which is being erected in England. The sketch drawings mentioned in the specification have been omitted, as there was not time to have copies made before I left England.

The ballistic pendulum is shown in detail on the plan furnished herewith. I may mention that the bob of the pendulum consists of a 13″ mortar, weighing 5 tons.

I have not yet received plans of the gun which it is proposed to use in England.

It will be necessary to erect an observation chamber at least 15 yards from the gallery. The front wall should be substantial, and fitted with narrow horizontal windows, suitably protected against the possible, but very remote, chance of a disruptive explosion in the gas gallery.

It will also be necessary to provide several sheds, or a shed divided into compartments, to be used as a safety lamp room, oil store, coal store, coal dust disintegration. Two small magazines should also be erected for the storage of explosives awaiting test, and for detonators.

Narrow gauge rails will have to be laid for use in connexion with the gas gallery and pendulum. It would be convenient if the rails were so arranged that the guns in use could be shifted from the gallery to the pendulum, or vice versa, as required.

At the station in England it is proposed to install a gallery for testing safety lamps, but the details have not yet been settled. The general idea is that the explosive atmosphere will be prepared in the explosives testing gallery, and that a branch gallery of small sectional area will lead from the big gallery through the lamp testing chamber back of the gallery.

The estimated cost in England of the above is £3,000, but I would suggest that a second gun be obtained (cost about £600). These guns are manufactured in the Royal Arsenal, Woolwich.

As far as the chemical laboratory is concerned, the only special feature to be attended to is the provision of a separate compartment, or a small detached building with a north light, in which stability tests will be carried out. It is essential that the atmosphere in which these tests are carried out should not be contaminated with acid fumes.

A very small detached shed of a few cubic feet capacity should be erected to store samples of explosive submitted for chemical examination. It is not advisable to store these samples in the testing gallery magazine, as they will doubtless often be of low chemical stability.

I attach a rough sketch of the disposition of the new apparatus in England

(Signed) **A. Desborough,** Capt

(*Reprint.*)

3rd Session, 11th Parliament, 1 George V, 1910-11.

THE HOUSE OF COMMONS OF CANADA.

BILL 79.

An Act to regulate the manufacture, testing, storage, and importation of Explosives.

HIS Majesty, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows:—

SHORT TITLE.

1. This Act may be cited as *The Explosives Act*. Short title.

INTERPRETATION.

2. In this Act, unless the context otherwise requires,— Definitions.

(*a*) "Department" means the Department of Mines; "Department."

(*b*) "Minister" means the Minister of Mines; "Minister."

(*c*) "authorized explosive" means any explosive the manufacture of which has been authorized under this Act; "Authorized explosive."

(*d*) "explosive" means and includes gunpowder, blasting powder, nitro-glycerine, gun cotton, dynamite, blasting gelatine, gelignite, fulminates of mercury or of silver, fog and other signals, fireworks, fuses, rockets, percussion caps, detonators, cartridges, ammunition of all descriptions, and every other substance, whether chemical compound or mechanical mixture, which has physical properties similar to those of the substances above mentioned, and every adaptation or preparation of everything above named; "Explosive."

(*e*) "factory" means and includes any building, structure, or premises in which the manufacture or any part of the process of manufacture of an explosive is carried on, and any building or place where any ingredient of an explosive is stored during the process of manufacture; "Factory."

(*f*) "inspector" means and includes the chief inspector of explosives, an inspector of explosives, a deputy inspector of explosives, and any other person who is directed by the Minister to inspect an explosive or explosive factory or magazine, or to hold an inquiry in connexion with any accident caused by an explosive; "Inspector."

"Magazine."

(g) "magazine" means and includes any building, storehouse, structure, or place in which any explosive is kept or stored; other than at or in and for the use of a mine or quarry in a Province in which provision is made by the law of such Province for the efficient inspection of mines and quarries;

"Occupier."

(h) "occupier" means any person who operates a factory for manufacturing explosives, or is the manager of or in charge of such factory, or who is the occupant of or uses a magazine for the storage of explosives;

"Regulations."

(i) "regulations" means any regulations made by the Governor in Council under the authority of this Act;

"Safety cartridges."

(j) "safety cartridges" means cartridges for guns, rifles, pistols, revolvers, and other small arms, of which the case can be extracted from the small arm after firing, and which are so closed as to prevent any explosion in one cartridge being communicated to other cartridges.

Departments exempted.

3. This Act does not apply to the Department of Militia and Defence or the Department of Naval Service.

IMPORTATION, MANUFACTURE, AND USE.

Explosives prohibited unless authorized.

4. Except as herein provided, no person shall have in his possession, or import, store, use, or manufacture, whether wholly or in part, or sell, any explosive unless such explosive has been declared by the Minister to be an authorized explosive.

Small quantities excepted.

5. Nothing in this Act shall apply to the making of a small quantity of explosive for the purpose of chemical experiment, and not for practical use or sale.

Certain process prohibited.

6. Except in so far as may be permitted by regulations made under this Act, no person except in licensed, manufacturing factories, shall carry on any of the following processes, namely: of dividing into its component parts, or otherwise breaking up or unmaking, any explosive; of making fit for use any damaged explosive; or of remaking, altering, or repairing any explosives; provided that this section shall not apply to the process of thawing explosives containing nitro-glycerine, if a proper apparatus or thawing-house is used.

LICENSES AND PERMITS.

Licenses.

7. The Minister may issue licenses for factories and magazines, and no one shall manufacture, either wholly or in part, or store explosives except in licensed factories and magazines.

Permits for importation.

8. The Minister may issue permits for the importation of authorized explosives, and no one shall import any explosive into Canada without such permit; provided, however, that nothing in this section shall prevent any explosive from being transported through Canada by railway in bond, if such transportation is made in a manner authorized by *The Railway Act* or any regulation or order made thereunder.

Transport in bond.

Special permits.

9. The Minister may, on application, and on payment of the prescribed fees, issue a special permit to import, for the purpose of chemical analysis or scientific research, an amount not exceeding two pounds of any explosive specified in such permit.

Application for license.

10. Application for factory or magazine licenses shall be made in such form and manner as are prescribed by regulation, and the application shall be accompanied by,—

Plan of factory and premises.

(*a*) a plan, drawn to scale, of the proposed factory or magazine, and of the land on which such factory or magazine is situated, and also of the lands adjacent thereto on which buildings are erected, with the uses to which such lands and buildings are now put. Such plan to have the exact distances between the several buildings marked thereon;

Description.

(*b*) a description of the situation, character, and construction of all buildings and works connected with the factory or magazine, and the maximum amount of explosive to be kept in each building;

Statement of employes.

(*c*) a statement of the maximum number of persons to be employed in each building in the factory or magazine;

Required information.

(*d*) any information or evidence which the Minister may require;

Statement of maximum amount and ingredients.

(*e*) in the case of an application for a factory license, a statement of the maximum amount of explosive, and of ingredients thereof wholly or partially mixed, to be allowed at any one time in any building, machine, or process of the manufacture, or within the distance from such buildings or machine which is limited by regulation;

Statement of processes and position of explosives.

(*f*) a statement of the nature of the processes to be carried on in the factory and in each part thereof, and the place at which each process of the manufacture, and each description of work connected with the factory is to be carried on, and the places in the factory at which explosives and anything liable to spontaneous ignition, or inflammable or otherwise dangerous, are to be kept.

Consent of municipality and Minister before license granted.

11. No license shall be granted for any factory or magazine hereafter established within the limits of, or within one mile of the limits of, any city, town or incorporated village, or elsewhere except with the approval of the municipal corporation or other local authority having jurisdiction, or the Government of the Province, if in a Province, and in territory where there is no local authority having jurisdiction, and also with the consent of the Minister.

Permits for experiments, and testing new explosives.

12. The Minister may, on application and on payment of such fees as are prescribed by regulation, issue a permit to manufacture for experimental purposes or for testing and special blasting operations only, and not for sale, any new explosive, upon such conditions and subject to such restrictions as are fixed by the Minister.

Permit for alteration or addition to factory.

13. The owner or occupier of a factory or magazine shall not make any material alteration or addition to a licensed factory or magazine, or rebuild any part thereof, until he has obtained a per-

mit from the Minister; and before such permit may be granted he shall submit such plans and other information and evidence as the Minister may require.

Change of owner or occupier.

Notice to Minister.

Penalty.

14. A factory or magazine license shall not be affected by any change in the person of the owner or occupier of the factory or magazine; but notice thereof, with the address and calling of the new owner or occupier, shall be sent by the owner to the Minister within three months after such change, and in default thereof, the new owner and occupier shall each be liable to a penalty not exceeding one hundred dollars for every week during which such default continues.

License for factory now in operation.

Proviso.

15. In the case of a factory now in operation or a magazine now in existence, no license shall be required until the first day of January, one thousand nine hundred and sixteen; provided, however, that if the owner or occupier of such factory or magazine desires to make any material alteration in or addition to such factory or magazine, or to rebuild the same or any part thereof, he shall comply with the provisions of section 13 of this Act.

Application for continuing certificate.

Particulars.

2. The owner or occupier of any such factory or magazine shall, within three months after the passing of this Act, make application to the Minister for a continuing certificate, stating in such application his name and address and the situation of the factory or magazine, and shall supply such particulars and information respecting the same as the Minister may require; and the applicant shall, thereupon, be granted a continuing certificate in such form as may be prescribed by the Minister, and such factory or magazine shall thereupon be deemed to be duly authorized to manufacture and store explosives.

Powers of Minister in case of special danger.

3. Notwithstanding anything in this section, the Minister may require the owner or occupier of any factory or magazine to stop using, or to use only under and subject to conditions to be specified by him, any building, structure, or premises which, from its situation or from the nature of the processes carried on therein, constitutes, in his opinion, a special danger.

INSPECTORS.

Appointment of inspectors.

16. The Governor in Council may appoint a chief inspector of explosives, one or more inspectors of explosives, one or more deputy inspectors of explosives, and a chemist of explosives.

Powers of inspectors.

17. An inspector may, at any time, visit and inspect any factory, magazine, and premises where any explosive is being manufactured or stored, or where he has reason to suspect any explosive is being manufactured or stored, and to open and examine any package that he may there find; and the owner and occupier of such factory, magazine, and premises, shall afford such inspector every facility to make such inspection full and complete, and shall supply the inspector with any information that he may require, other than information relating to the cost of manufacturing any explosive.

2. An inspector may require the owner or occupier of any factory or magazine, where any explosive is manufactured or stored, or any person employed in any such place, to give him such samples as he may require of any substance therein, whether in the state of raw material, material in course of manufacture, or manufactured material, which the inspector believes to be an explosive, or to be an ingredient from which an explosive may be manufactured. May require samples.

3. An inspector may, at any time, open or cause to be opened any package or store of material of whatsoever nature, which he believes to contain explosives or ingredients for the manufacture of explosives. May open packages.

INQUIRIES INTO EXPLOSIONS.

18. The Minister may direct an inquiry to be made whenever any accidental explosion of an explosive has occurred, or when any accident has been caused by an explosive, and the person authorized by the Minister to conduct such inquiry shall have all the powers and authority of a commissioner appointed under Part I of *The Inquiries Act.* Inquiry into accidents.

2. This section shall not apply, however, where an accident has been caused by an explosion of an explosive occurring in any mine or quarry, or metallurgical work in any Province in which provision is made by the law of such Province for a proper and thorough investigation and inquiry into the cause of such accident. Exemption: where covered by Provincial legislation.

REGULATIONS.

19. The Governor in Council may make regulations,— Regulations.

(*a*) for classifying explosives, and for prescribing the composition, quality, and character of explosives; Classify explosives.

(*b*) prescribing the form and duration of licenses, permits, and certificates issued under this Act, the terms and conditions upon which such licenses, permits, and certificates shall be issued, and the fees to be paid therefor; Licenses, Permits, and certificates.

(*c*) for regulating the importation, packing, and handling of explosives, and the transportation of explosives otherwise than by railway; Importation, packing, and transportation.

(*d*) for inquiries into the accidental explosion of explosives, and any accident caused by explosives; Inquiries into accidents.

(*e*) for the taking of samples of explosives required for examination and testing, and for the establishing of testing stations, and of the tests and other examinations to which explosives shall be subjected; Samples. Testing.

(*f*) prescribing the manner in which an explosive shall be tested and examined before it is declared to be an authorized explosive, and for determining to what examinations and tests authorized explosives shall be subject; Authorized explosives.

(*g*) to be observed by inspectors and other officers and employes charged with any duty under this Act, or under any regulations made thereunder; Inspectors and officers.

Factories. (*h*) relating to the construction and management of factories and magazines;

Safety of public and employes. (*i*) for the safety of the public and of the employes at any factory or magazine, or any person engaged in the handling, or packing of explosives, or the transportation of explosives otherwise than by railway;

Location and manufacture. (*j*) governing the establishment, location, and maintenance of factories and magazines, and the manufacture and storage of explosives;

Operation of Act. (*k*) for the more effective carrying out of this Act.

Publication. 2. All regulations made under this Act shall be published in *The Canada Gazette*, and upon being so published they shall have the same force as if they formed part of this Act.

OFFENCES AND PENALTIES.

Obstruction of entry and examination by inspector. **20.** Every person who fails to permit an inspector to enter upon any property, and to inspect, examine, or make inquiries in pursuance of his duties, and every person who fails to comply with any order or direction of such inspector, in pursuance of the requirements of this Act, or any regulation made thereunder, or who, in any manner whatsoever, obstructs such inspector in the execution of his duties under this Act, shall be liable to a penalty not exceeding five hundred dollars and costs. Penalty.

Manufacturers objections to Inspectors ruling referable to Minister for adjudication. 2. Any manufacturer who takes exception to the ruling of an inspector, before such ruling or before the penalty provided for in subsection (1) one of this section is enforced, as the case may be, may have the facts upon which such ruling is based submitted to the Minister for his consideration and decision.

Trespassing upon premises. Penalty. **21.** Every person who enters without permission or lawful authority, or otherwise trespasses upon any factory or magazine, shall, for every offence, be liable to a penalty not exceeding fifty dollars and costs, and may be forthwith removed from such factory or magazine by any constable, or by any person employed at such factory or magazine.

Causing explosion or fire. Penalty. **22.** Every person who commits any act which is likely to cause an explosion or fire in or about any factory or magazine, shall be liable to a penalty not exceeding five hundred dollars and costs.

Possession, sale, manufacture, or importation of unauthorized explosive. **23.** Every person who, by himself or his agent, has in his possession, sells, offers for sale or manufactures or imports any unauthorized explosive within the meaning of this Act shall, for a first offence, be liable to a penalty not exceeding two hundred dollars and costs, or to imprisonment for a term not exceeding three months, or to both penalty and imprisonment, and for each subsequent offence shall be liable to a penalty not exceeding five hundred dollars and costs, and not less than fifty dollars and costs, or to imprisonment for a term not exceeding six months, or to both penalty and imprisonment. Penalty.

24. Every person who violates any provision of this Act for which a penalty has not been provided, or any regulation made thereunder, shall, for a first offence, incur a penalty not exceeding two hundred dollars and costs, and for each subsequent offence a penalty not exceeding five hundred dollars and costs. Contravention of Act. Penalty.

25. Every penalty and forfeiture may be recovered in a summary manner under the provisions of Part XV of *The Criminal Code.* Recovery of penalties.

COMMENCEMENT OF ACT.

26. This Act shall come into force on a day to be fixed by proclamation of the Governor in Council. Commencement of Act.

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